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UNIVERSITY OF MARYLAND
AGRICULTURAL EXPERIMENT STATION

**SERVING AGRICULTURE
THROUGH RESEARCH**

SEVENTY-THIRD ANNUAL REPORT
BULLETIN A-116 JUNE 1961

SERVING AGRICULTURE



THROUGH RESEARCH

SEVENTY-THIRD ANNUAL REPORT

1959-1960

VERSITY OF MARYLAND
CULTURAL EXPERIMENT STATION

BULLETIN A-116
COLLEGE PARK
MARYLAND
JUNE 1961

BOARD OF REGENTS OF THE UNIVERSITY OF MARYLAND
AND THE MARYLAND STATE BOARD OF AGRICULTURE
1959-1960

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UNIVERSITY OF MARYLAND
AGRICULTURAL EXPERIMENT STATION
COLLEGE PARK, MD.

*To The Governor of Maryland,
the Board of Regents,
and the President of the University of Maryland*

I transmit herewith the Seventy-Third Annual Report of the University of Maryland Agricultural Experiment Station, as established by Act of Congress, March 2, 1887, containing an account of research and experiments conducted during the fiscal year ending June 30, 1960, and a statement of the receipts and disbursements for the same period.



Director

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The project number is given after each progress report. The title of the project and the personnel associated with it can be found listed among the current projects on pages 77-84.

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*Contribution No. 3258 of the
Maryland Agricultural Experiment Station*

AGRICULTURAL ECONOMICS

Economic research is essential for the efficient operation of the intricate marketing system for agricultural products, as well as for economical production. New techniques and procedures need to be evaluated carefully in order to assure effective operation. Agricultural development is dependent upon sound economic research.

Study Shows Advisability of County-State Tax Planning

New tax sources and tax rate increases have been the methods of providing for rising governmental costs in recent years in Maryland. Revenue supply has been curtailed by various types of exemptions and by levies based on unit measurements rather than value. Property taxes have kept closer to government demand trends than have most other revenues. There are other levies based on value concepts, such as income and sales taxes, which could be used to a greater extent for a more productive tax system. This would also assist in keeping down farm property taxes.

The tax system could be made more effective by improvements in sharing relationships between state and counties. This means that state allocation formulae for providing aid to counties should be designed to supplement the

tax resources of those counties where needs exceed such resources. Thus, all allocation formulae could be profitably reviewed with the purpose of providing at least an acceptable or basic functional program in all counties. This could be done by measuring county functional needs on a common denominator basis and using uniform measurements of abilities of the various counties.

Property taxes per capita have increased at a more rapid pace than other revenues have in recent years. Therefore, it becomes necessary to give emphasis to other sources of revenue, especially at the state level, and to use them for purposes of sharing with counties for functional programs, if property taxes are to be kept within reasonable limits.

(Project A-19-u)

Vertical Integration Effects Studied

On the average in the United States, farmers receive less than 40 percent of the consumer's dollar spent for food and fiber. The exact amount varies among regions of the country and according to the specific product. However, the size of the farmer's share of the consumer's dollar spent for food and fiber gives some indication of the vast number of individuals and operations through which farm products pass between the farmer and the ultimate consumer. Traditionally, farm operations and off-farm operations have been

tied together by the price system. During the last two decades, the decision-equilibrating influence of price has been partially displaced by other means. In Maryland this has been most prevalent in the broiler industry and in the vegetable processing industry. The most common terms used in describing this phenomenon are vertical integration or contract farming. The most important feature of this form of business organization is centralization of decision-making, risk-bearing and supervision. Parties of the contract agree to furnish

certain materials and services and perform certain operations in a specified manner. Therefore, each is enabled to conduct his productive activities with greater knowledge than previously.

Advantages and disadvantages to individual farmers depend on several factors. Vertical integration has been beneficial to many farmers by increasing available capital and thereby permitting them to enter certain types of farm production or expand production which otherwise would not have been possible. This would not represent an advantage to farmers not restricted by capital limitations. Off-farm firms must be compensated for the materials and services which they supply. Therefore, farmers under contract receiving these materials and services for use in their production receive less than those that do not enter contractual relations. Since this aspect also applies to losses, farm-

ers under contract do not bear losses as great as non-contracting farmers when these occur due to unexpected changes in costs and prices. Thus, net incomes to contracting farmers usually fluctuate over a smaller range than do incomes to non-contracting farmers. This is particularly outstanding during periods when prices of the product are at extremely low levels.

There are indications that the total quantity of output from an industry that is highly integrated is greater at given prices than output from an industry in which there is little or no vertical integration. If this is true, the general level of prices may be expected to be lower. Thus, vertical integration may be expected to help stabilize farmers' net incomes and permit consumers to purchase finished products at lower prices.

(Project A-18-aq)

Investigate Quality Controls of Processed Vegetables

Maryland vegetable processors have encountered increasing competition from other regions. Whereas Maryland has had a relatively large number of small-scale processing firms, some of the major competing regions are characterized by the presence of larger firms, which presumably are better adapted to meeting the trend toward large volume purchases by food distributors. The requirements of such large-scale buyers might be met more satisfactorily by smaller processors through the operation of a joint selling organization.

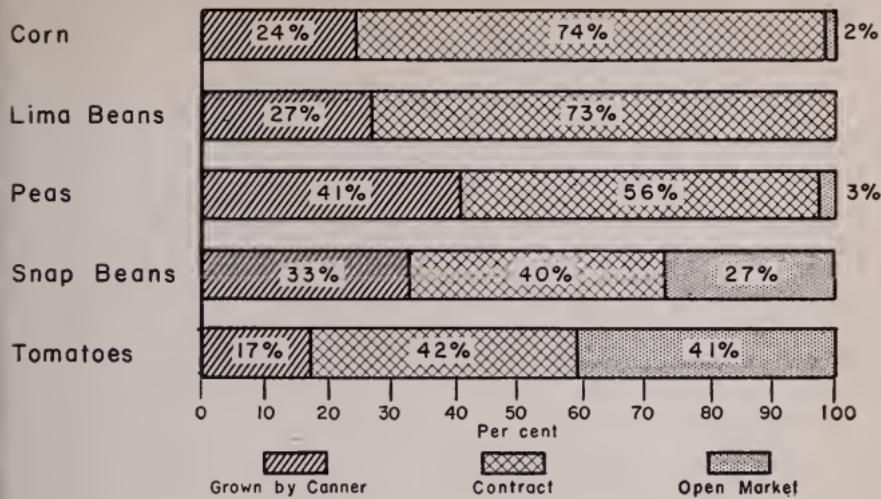
As part of a regional project studying the various aspects of group marketing, this project deals with problems involved in obtaining uniform quality of processed vegetables which would be packed by member plants and would be sold under a common label. Concurrently, quality practices and goals of

individual firms are being studied in order to analyze the adaptability of existing firms to changing market structure.

A survey of 50 vegetable canning firms has been completed. Information was obtained on the extent of processors' control of quality of the raw product in the various production stages and on inspection and grading practices as a basis of payment to growers. In-plant quality control, inspection and grading practices were studied to determine processors' differentiation of quality levels of the canned product.

Findings of this study will indicate the extent to which processors differ in quality control practices. Further analysis will suggest alternative methods of attaining quality uniformity under a joint selling arrangement.

(Project A-26-ba)



Survey Market Outlets and Methods of Marketing Poultry

As a result of a survey of market facilities and their utilization in the handling of chickens and turkeys in Maryland, volume of fowl and turkeys accounted for 14 and 5 million pounds, respectively, in the plants surveyed. Large processors, one of the principal handler groups included in the study, purchased the greatest volume of broilers, farm fowl and turkeys, in that order. Seasonality of supply and price made it difficult to develop a continuing market for farm fowl and turkeys. Supplies of fowl were inadequate for market demand in the State during the period of March through May. Prices varied inversely with volume handled, and were highest at the farm level in November and December. The largest single outlet available to processors of this commodity was retail stores, with wholesalers and institutions requiring sizeable volumes. Processors indicated their margins ranged from 15 to 17 cents per pound processed, and shrinkage ranged from 25 to 27 percent (live weight basis). The average weight of birds sold was 5.2 pounds and average farm price for the year was 17.8 cents.

At the time of this study, the number of turkeys produced in Maryland was declining. More turkeys were marketed in November and December, with farm prices averaging highest during this season of the year. The increased demand during the holiday period more than offset the quantity offered. Producer-processors took advantage of the opportunity for product differentiation by marketing freshly killed turkeys direct to consumers and institutions in the area. With a decline in turkey production, it appeared likely that major emphasis will be given to direct marketing. A margin of 17 cents was typical among turkey processors in this area. Shrinkage in processing averaged 23 percent. About 54 percent of all turkeys produced were Beltsvilles, with the remaining percentage consisting of heavy breeds, principally Bronze.

With respect to turkey marketing and distribution, it seemed feasible for turkey producer-processors to continue efforts in developing direct sales to consumers and institutions.

(Project A-26-ax)

Seek Answers to Cooperatives' Success

The success of any farmer cooperative is measured by the facilities and services available to the members. It is essential to the cooperatives to have a well-informed membership and for the cooperative officials to be aware of the needs and desires of the members.

The extent to which Maryland cooperatives are engaged in membership relations and education work is being ascertained by interviews with cooperative officials and a sample of their memberships. Fifteen cooperatives were selected for this study, representing the marketing, purchasing and service cooperatives in the State. Mail questionnaires were sent to a 5.5 percent sample of the cooperative members. From this number a 15 percent response was obtained.

Of the total number of members reported by the cooperatives, only 15 percent attended the annual meetings. Of the sample of members interviewed, 25 percent gave "not interested" as their reason for not attending the annual meetings. In all cases, the members reported that the annual financial reports were adequately explained.

Contributions to farm youth programs in the various operating areas averaged approximately \$134 per coop-

erative. While the majority of the members felt that their cooperatives should support youth activities, none of the cooperatives sampled was directly sponsoring any types of farm youth programs.

House organs were generally sent to selected patrons, whether members or non-members. House organs were sent to 12,348 persons by the 13 cooperatives, which was two-thirds of the total number of current patrons.

There was a wide range of knowledge concerning the cooperatives' activities among the members sampled. In many cases, suggestions were made for improving the various membership relations programs, but no strong opinions were voiced in criticism of the cooperatives' programs.

Approximately 3 percent of the members as taken from the cooperatives' membership lists were reported deceased, no longer farming or did not consider themselves members of the cooperatives. This indicated the need for a review of the membership lists in some cases and in others perhaps a better understanding of the membership requirements and obligations.

(Project A-26-b)

Consider Costs of Artificially Dried Hay

High-quality forage is essential to obtain relatively high levels of milk production per cow and rapid rates of gain in young cattle with relatively low levels of grain feeding. A recent development in the production of quality hay is the use of a hay drier. However, considerable additional expense is incurred on farms which dry hay artificially.

The total fixed investment in hay drying equipment ranged from \$600 to \$6,825 on the 24 farms studied during the summer of 1959. Total investment in mow drying equipment with the use

of unheated air ranged from \$600 to \$1,580. In contrast, the investment ranged from \$2,093 to \$6,825 on farms with hay drying systems which used a heat exchanger.

The tonnage of hay dried by farmers who used hay driers ranged from 18 to 400 tons. Total hay drying costs, which include fixed costs as well as the variable costs, ranged from \$2.81 to \$20.45 per ton dried for the systems using heat. The weighted average cost was \$5.05 per ton.

For the mow systems without heat,

the range in total costs was from \$0.98 to \$6.21 per ton dried. The average cost of unheated mow driers was \$2.24 per ton dried.

The critical questions with most dairymen trying to decide whether or not to dry hay artificially are: Will the additional milk response and sales of

Vegetable Yields Increase; Acreage, Output Decline

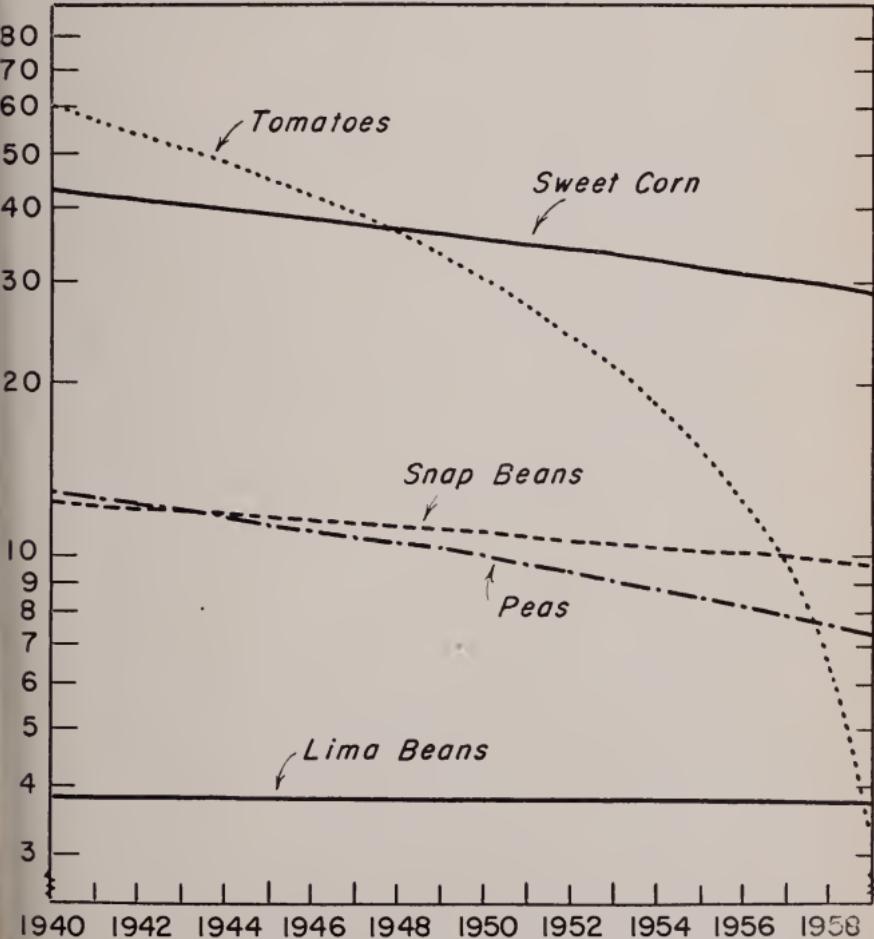
Total acreage devoted to the five most important vegetable crops produced for processing in Maryland de-

THOUS. ACRES

milk more than pay the costs of drying hay? Will tonnage of hay to process through the drier be large enough to justify the cost? Do I have more profitable alternatives in which to use the capital funds such as additional fertilizer or additional feed grains?

(Project A-18-ao)

clined more than 50 percent during the last 15 years. Total output also declined despite increases in yield per acre. These



How Maryland's major processing vegetables were procured in 1958.
Trends in harvested acreages of certain vegetables for processing, Maryland, 1940-59.

changes have had widespread effects on Maryland farms as well as on many non-farm businesses. They also indicate the vast adjustments which are slowly emerging in the Maryland agri-business economy. Perhaps more important, they indicate major adjustments in both farm and off-farm food-producing firms which remain to be made. Though vegetable production for processing remains an important enterprise on a large number of farms, the proportion of total gross farm receipts from these crops in Maryland is only about one-half what it was 20 years ago.

In many cases, farm land previously used in producing vegetable crops for processing was shifted to other farm enterprises, primarily corn and soybeans. Changes in prices of vegetable crops and alternative farm enterprises were similar over the period. However, average annual gross value per acre of crops other than vegetables rose a little more rapidly than that of vegetable crops because of the slightly greater stability in yields. Therefore, changes in relative profitability of vegetables for processing and other enterprises were due largely to changes in costs of production. Though costs of production of all farm products increased, costs of producing vegetable crops generally rose

more than some other products. For example, between 1941 and 1958 average costs of hired labor usually required for vegetable production increased more than two and one-half times, while costs of farm machinery increased approximately one and one-half times. Since highly mechanized methods generally were more adaptable to crops, particularly grain, the most profitable enterprise on many farms shifted from vegetables toward other crops.

These changes in farm output inevitably spread to the vegetable processing industry through a declining flow of raw product. As the raw product flow is decreased, average unit costs of processing rise since a large part of the costs of processing does not vary proportionately with level of output. Concurrently, production of processed vegetables kept increasing in other important producing regions. Therefore, prices received by processors were kept from rising sufficiently to offset higher costs. If unimpeded, these changes are likely to result in further curtailment in net revenues of the Maryland processing industry. Thus, considerable adjustments will still have to be made in the Maryland food-producing economy.

(Project A-18-ap)

Milk Processing and Distribution Varied and Dynamic in Maryland

A very wide range exists in milk processing facilities and dealer organizations in the state. There are nine dealers operating plants in Baltimore whose wholesale and retail routes compete with each other and/or small local dealers in 17 of the 23 Maryland counties. Approximately 30 small dealers located in 14 counties outside of Baltimore and the District of Columbia are in competition with each other, with Baltimore dealers, with District of Columbia dealers and with dealers from surrounding states of Pennsylvania and

Delaware in the distribution of milk at wholesale and retail.

About one-fifth of the local milk distributors in the State are engaged primarily in the handling of their own production, and purchase relatively small quantities of milk from other producers, from producer-cooperatives or other dealers. A few of these limit their operations to the distribution of milk in paper and glass containers which they purchase from dealers who have processing facilities.

The trend in recent years has been

toward more extended wholesale routes from large metropolitan processing plants. This extension into more distant areas has been characteristic of the major dealers in both Baltimore and Washington, D. C. It has contributed to competitive conditions among themselves and with local handlers which

led to hidden discounts, rebates, gifts, loans and a wide variety of services on the part of distributors who were seeking to increase or maintain their wholesale business with large outlets, particularly chain stores and supermarkets.

(Project A-26-bc)

Study Finds Characteristics of Broiler Flocks Sold at Auction

Information obtained on 1,331 broiler flocks sold at the Eastern Shore Poultry Growers Exchange, June, 1957-59, shows that flocks averaged 8,443 birds. They were sold at an age of 66.5 days and averaged 3.33 pounds per bird. The principal breed was Vantress-Arbor Acre, which accounted for 71 percent of the total. Prices ranged from 12.6 cents to 24.2 cents and averaged 18.7 cents per pound.

During the period covered in the study, 13 buyers purchased fewer than 25 flocks, six buyers bought 25 to 50, five bought 50 to 75 and six buyers bought more than 75 flocks. Broiler prices were not closely associated with the condition of the flock, based on the data made available. External factors,

including aggregate supply and demand, appear to have greater influence on prices on a given day. There seemed to be no relationship between price and size of flock. Variation in average weight and age sold were virtually unrelated to flock size.

Higher prices were received for birds sold on Tuesday and Friday when sales were heaviest. Thirty-six percent of the flocks were sold on Tuesday, 29 percent on Friday, and 19 and 16 percent, respectively, on Thursday and Wednesday.

Relationships of flock characteristics and prices received at the time of sale are in the process of analysis.

(Project A-26-am)

AGRICULTURAL EDUCATION

Research in agricultural education is concerned primarily with helping rural leaders in agriculture work more effectively in raising the educational level of rural youth and adults. As research in technology reveals more and more new information, better methods of disseminating that information must be found. The rapidly changing patterns of human behavior should be based upon the latest and most accurate information available. Research in agricultural education aims to accelerate this process.

Educational Campaigns Help Remove Farm Safety Hazards

Farming is more dangerous than any other major occupation except mining and construction work. A study completed during the past year reveals that farm accidents can be reduced by conducting educational safety campaigns in rural communities. In nine communities where safety campaigns were conducted, there were only one-sixth as many farm accidents and one-third as many people killed as in other communities.

The safety campaigns were coordinated through the vocational agriculture departments in the communities. An opinion poll revealed that the reaction to the safety campaigns was highly favorable among students, school

staff and farmers.

Procedures recommended by over half of the cooperating teachers of vocational agriculture were:

1. Conduct safety campaigns during the winter months.
2. Limit the campaign to 60 days.
3. Appoint small teams to survey farms for accident hazards.
4. Conduct a campaign annually.
5. Use some form of competition within youth groups to develop interest.
6. Make safety education a part of the vocational agriculture course of study.
7. Limit the farm inspection part of the campaign to eleventh and twelfth grade students.

(Project T-4)

What Makes Students Succeed in College of Agriculture?

Educators have tried for many years to determine high school courses that best prepare students for success in college. This study was initiated to determine the experience factors that significantly contribute to graduation in the College of Agriculture. High school courses and experiences will be evaluated in terms of subsequent success of freshman students enrolled in the College of Agriculture beginning with the Fall semester, 1959. A review of experiences of students in the College of Agriculture led to the conclusion that

attrition rate and percentage of student failures during the freshman year warranted investigation. These data will be of value in recruiting students who possess a background of educational experiences appropriate for study in the College of Agriculture. High school administrators and guidance counselors need such information for planning instructional programs for students who are interested in preparing for professional careers in agriculture.

A comprehensive review of literature including 103 studies pertinent to the

problem was conducted. Most of the investigations were conducted by advanced degree candidates and teacher trainers at land-grant institutions. Considerable variety existed in the units of an analysis used to measure college success. The most frequently used measures were scholastic achievement, election to honor societies, college attrition rate, number of students who entered agricultural occupations and participation in extra-curricular activities. Dimensions used to measure academic achievement were grades in all college work for four years, grades for all college work for a specific period of time, grades in selected courses and grades in groups of courses.

A disproportionate number of researchers evaluated vocational agriculture in terms of preparation for college. The review of literature revealed that vocational agriculture was as adequate as other courses in preparing students for study in the College of Agriculture. In general, research indicated academic

success in college did not depend on the study of certain high school subjects. Previous successful achievement as measured by high school rank was, perhaps, the most valid criterion for predicting scholastic success in college reported in the studies reviewed.

Schedules have been prepared and collection of data is in process. Student information will be secured in the following areas: secondary school record, kind and size of high school, family social and economic status, factors influencing student enrollment in the College of Agriculture, agricultural experiences prior to college enrollment, university scholastic achievement and participation and leadership in extra-curricular activities. Data have been collected on students not in academic difficulty who terminated their studies prior to graduation. An analysis will be made of the reasons given by students for discontinuing their education.

(Project T-6)

AGRICULTURAL ENGINEERING

Agricultural engineering, through efficient application of physical science, seeks to provide optimum environment for biological processes of plants and animals as well as personnel engaged in production, processing and marketing of food and fiber products. Cumulative and irreversible biological processes frequently pose rigid requirements for optimum development but end-product values often prevent adequate investment. Agricultural engineers, in cooperation with other agricultural scientists, conduct research to determine optimum relationships between rates of biological change and labor requirements for production and management or physical facilities. In some cases, minimum biological change is desired, whereas, in other instances, maximum rates of change are the specific requirement.

The resumes of research project activities which follow delineate studies of primary responsibility. The Department cooperates with other disciplines to provide specific engineering support on certain projects, and the staff members serve as engineering consultants for the entire Agricultural Experiment Station staff.

Complete Study of Tobacco Curing Conditions

The series of studies designed to determine the optimum curing conditions for Maryland tobacco was completed. These studies covered combinations of

Facilities for controlled environment permit barn testing of the most favorable conditions for tobacco curing, as determined in small research rooms.



temperatures of 60, 70, 80 and 90° F. and relative humidities of 60, 70, 80 and 90%. These tests required four seasons to complete, and the most popular variety, Catterton, was used. A condition of 80° F. and 80% relative humidity was repeated each year to permit comparison of year-to-year variations. The results have indicated that a temperature of 80 to 90° F. and a relative humidity between 75 and 80% are required to produce optimum curing conditions.

Studies were conducted to determine the loss of weight, loss of dry matter and rate at which tobacco plants lose weight during curing. The plants lose weight most rapidly during the first 10 days, and at the end of 20 days the plants have lost 88% of the initial green weight and the moisture content has dropped from 87.6% to 30%. The plants lose approximately 2% of the initial dry weight during curing. The leaves lose 3.5 to 4%, while the stalks gain from 1 to 2% in dry weight during this period.

Tests were continued on comparison of natural curing with controlled curing in standard size barns. The controlled conditions were used when it was necessary to modify the natural conditions to maintain optimum conditions in the

barn. The controlled barn had facilities to automatically heat and to humidify or dry the air entering the tobacco. Preliminary evaluation of the results indicates that the two were very good and about equal. *(Project R-11-d)*

Test Structures and Equipment for Tobacco Stripping

A second stripping room conditioner was installed for test during the 1959-60 season. Studies were continued using the units to control environmental conditions in tobacco stripping rooms. The second system was installed in the stripping room at the University of Maryland Tobacco Research Farm. This system used a vertical type, warm air furnace and was installed in an adjacent room. The unit discharged conditioned air at the ceiling with the intake air being taken from near the floor. This type of circulation was more satisfactory than that of the previous horizontal unit installed in the room. The conditioner using the horizontal furnace was used in a farmer's stripping room. Both systems performed very satisfactorily and did an outstanding job of producing the desired conditions. Workers were unanimous in their comments to the effect that dust was, for practical considerations, eliminated from the stripping room. This equipment will help the farmer to do a better, faster and more economical job of stripping and handling tobacco. The farmer can use his labor more effectively and continuously during the winter months.

(Project R-11-e)



An upright fuel oil furnace is the source of heat for this tobacco stripping room conditioner. The bottom duct is the intake from the stripping room. The discharge duct from the surface humidifier with water tank are placed as high as the ceiling will permit.

Improve Equipment for Chopped Forage Handling

This year the major effort went toward obtaining a more uniform flow of material into the air stream so that the data collected could be analyzed.

A conveyor 36 inches wide, 18 inches deep and 84 feet long was constructed and placed at 90° to the high speed conveyor in an attempt to overcome the

problem of non-uniformity of the flow of material from the feeding system into the air stream. The conveyor has a variable speed drive so that the belt speed can be controlled to change the rate of feed. The rate of feed was determined by weighing the material as it was placed uniformly on 4-foot increments of the conveyor and by the conveyor belt speed. The discharge end of the conveyor was equipped with a raking section that tore the hay apart and fluffed it up before discharge into the high-speed conveyor. The purpose of

fluffing was to reduce the chances of large clumps of material being fed into the system. This method of feeding improved the uniformity of the flow of material into the system.

In an attempt to obtain a better idea of the interaction between the air and the material in the system, plexiglass observation sections were constructed. High-speed movies taken of this interaction showed considerable tumbling of the material, indicating turbulence in the air stream. *(Project R-16)*

Design New Machine for Sweet Potato Harvesting

A new machine was designed and built in the department shop. This machine was designed to cut the vines on either side of the row, pick up those vines between the two cutters and then cut them from the main plant. Weakness in the part of the machine which removed the vines after cutting prevented extensive harvesting research with this machine. It did an excellent job of removing the vines from the top of the ground over the entire row area.

The second development was the redesign of a commercial machine using a vertical shaft engine of the single

cylinder, high-speed type. This made possible mounting the machine between the front and back wheels of the tractor, with the potato digger towed behind the tractor, thus making the entire operation a once-over harvest. Both of these machines had one thing in common. The underground parts of the plant, coarse and fine roots, were not removed from the potatoes. This makes collection of the crop difficult by either hand or mechanical means. Removing the potatoes from the vines was difficult.

(Project R-20)



Experimental machine designed to remove sweet potato vines from the full row width.

AGRONOMY

Research in Agronomy is directed toward providing new information that will permit progressive advances in efficient crop production. This objective involves development of better varieties and better crop and soil management practices. Due to the number of major crops covered (corn, small grains, soybeans, forage crops and tobacco), and to the wide range of soils in Maryland, the task is large.

The research program varies somewhat from time to time, depending upon the relative urgency of problems at hand or anticipated for the future. An indication of current activity is given by the following brief project reports.

Find Clues to Age of Maryland Soils

It is possible to tell the age of many rocks and geological formations that are millions of years old, yet it is very difficult to tell the age of soils that are sometimes just a few thousand years old. During the past year, the discovery of buried peat and trees under our Maryland soils will allow us to determine the age of soils on the Eastern Shore and in the Southern Maryland

Coastal Plain. Similarly in the Piedmont area, the discovery of marl deposits under black Rendzinitic soils should provide a clue for the age of certain soils formed in the Limestone Valleys. Soils of the Piedmont show signs of laterization and are among the oldest on the North American Continent.

(Project O-48; revised)

Why Are Most Soils Red or Yellow?

In spite of being formed on the same kind of rock or parent material, many soils are different, especially in color. We find these differences in color in every physiographic province of Maryland. As long as the color of two soils is different, they are usually classified in different categories. An attempt is being made to find out why colors vary abruptly in short distances and to relate these causes to important agricultural

properties. So far, our studies have indicated that red soils have more free iron oxides than yellow soils and that this difference, while being greater in older soils, is not appreciable in younger soils. Further studies will be directed toward answering the question: What is the chemical formula of iron under the red and yellow colors?

(Project O-54)

Trace Effect of Nitrogen, Plant Cover on Corn Yields, Soils

One hundred pounds of nitrogen per acre in the form of ammonia has produced maximum yields of corn during the last four years in a continuous corn experiment. Plots with a winter cover crop of rye and vetch seeded in the corn in August produced 96 bushels of corn per acre, but plots with 100

pounds of nitrogen applied when the corn was six inches in height produced 113 bushels. Corn receiving no nitrogen produced 83 bushels per acre. All plots received 1,000 pounds per acre of 0-20-20 fertilizer, and the corn stalks were not removed. Four hundred pounds of nitrogen per acre decreased

the corn yield about 4 bushels per acre below that of the plots fertilized with 100 pounds of nitrogen.

The cover crop and nitrogen had no effect on soil structure. However, there appeared to be a decline in all plots because of the continuous cropping

with a cultivated crop. It might be concluded from these results that nitrogen can be used to replace cover crops in continuous corn on land where erosion is not a serious problem.

(Project O-56)

Results Vary with Preplant Herbicides for Tobacco Plant Beds

Some newer materials for weed control in tobacco plant beds can be applied as a powder and drenched into the soil, or can be dissolved or diluted into large amounts of water before drenching. The need of a gas-tight cover, such as is required for methyl bromide, is eliminated by the water seal.

Although results varied considerably, vapam and Mylone were effective in weed control, but could be used only in the fall because of residual toxicity.

Stunted plants having an unusually dark-green color, thickening, and downward curvature of the margins, were found in spring-treated areas.

Bedrench, a mixture of 85% allyl alcohol and 15% ethylene dibromide, was effective in spring treatments. However, it presents a hazard to the operator, as the allyl alcohol is a severe lachrymator. For that reason, a warning against its use should be made.

(Project B-81)

Develop Improved Strains of Maryland Tobacco

Twelve strains of Maryland tobacco combining resistance to wildfire, mosaic and black root rot were studied in 1959. Bed and field inoculations for wildfire and common mosaic were employed.

A species of *Nicotiana* immune to black root rot had been crossed with tobacco in the breeding program. The resistance of the progeny was tested in

greenhouse soils heavily inoculated with the black root rot organism, *Theilavapis basicola*.

While none of the twelve strains were outstanding, the average yield and acre value compared favorably with Catterton, a popular farmers' variety. They were not equal to Wilson, however.

(Project J-95)

Study Supplement Irrigation Needs for Field Crops

Forage crop plots required five irrigations in 1959 if only moderate moisture deficits were allowed to develop, a total application of 8.59 inches. Where a higher stress was allowed to develop before irrigation, one application of 3.65 inches was needed. Seasonal yields ranged from .96 to 6.06 tons of dry matter per acre, both extremes being with Midland bermudagrass. Three rates of application of nitrogen, 100, 200 and 400 pounds per acre, produced yields in proportion to amount of nitrogen with bermudagrass and tall fescue. Ken-

tucky bluegrass was killed by the highest nitrogen rate, but was thrifty with less nitrogen. Varying rates of application of an 0-15-30 for alfalfa and Ladino clover had no real effect on yields. The overall benefit of irrigation was one-half ton per acre with frequent watering, one-fifth ton with a single large irrigation.

No water was added for tobacco in 1959, as drought did not develop until immediately before harvest. Responses to higher nitrogen rates were noted, with 90 pounds per acre outyielding a

60-pound treatment by 170 pounds and in dollar return by \$122. A further increase of nitrogen to 120 pounds per acre gave a yield response over the 90-pound rate of 101 pounds and an increased return of \$45. Higher plant populations were a less effective means of increasing returns, perhaps because of over-competition late in the season.

Soil moisture measurements were made with the neutron meter, tensiometers and gypsum blocks. The gypsum blocks were the least satisfactory method, as they were less sensitive. Tensiometers were very good at stresses well

below one atmosphere. The neutron meter behaved consistently over a wide range, and showed daily losses of 0.1 to 02 inches of water in a column of soil nearly 4 feet in depth and containing in that volume as much as 13 inches of water.

The tensiometers behaved well in the forage plants but were probably placed too deeply in the soil of the tobacco plots. It is necessary to keep the tip of the porous cup above the B horizon of the soil, otherwise it will not measure "tension" in the drier surface horizon.

(Projects BQ-83, NE-22)

Stations Cooperate on Climatological Studies

One million cards have been key-punched under the cooperative climatological program with the U. S. Weather Service. "Freeze" data, the last occurrence in the spring of freezing or other low temperatures; and the first occurrence in the fall of similar temperatures, have been submitted for 13 Mary-

land stations. A publication composed of similar data from the Northeastern states is being prepared.

Five stations have been processed for a precipitation study, with eight more nearing completion, again with a regional publication in mind.

(Projects BOQR-84, NE-85)

Complete Study of Tobacco Crop Rotations

A three-year rotation study was completed, and the results of seven years summarized. Crop successions in which non-legumes succeeded tobacco were superior to those involving legumes, although no significant differences in acre value were present. With either hairy vetch or Ladino clover, price per pound of the tobacco was decreased, offsetting the moderate gains in yield.

Ryegrass, wheat or redtop were equally effective in maintaining high quality.

One notable feature of this test was the relative stability of the yields, even in years of extreme high or low rainfall. The improvement in soil tilth was easily detectable in this series, and together with increased organic matter, served to buffer the crop against adverse conditions.

(Project B-68)

Investigate Forage Weed Control Problems

The use of chemicals to control chickweed in fall-seeded alfalfa has become one of the standard treatments by Maryland farmers. There are, however, still some problems which are being investigated. The optimum time of treatment with DN and CIPC has been studied, and it appears that DN is best applied in November with re-treatment

necessary through early March. The herbicide CIPC can be applied as early as October and will normally give full-season control of chickweed. This material cannot be used in an alfalfa-grass mixture seeded the same year. Recent research indicates that in established orchard grass-alfalfa mixtures, it may be used without injuring the grass.

Research is being conducted to determine the effect of 2,4-DB on alfalfa when used as a dormant spray to control wild turnip and yellow rocket. Various rates at various dates of treatment have been applied, and it appears that early treatments before alfalfa is com-

pletely dormant are harmful.

Preliminary observations of pre-emergence applications of herbicides indicates some new materials may be useful in controlling weeds until the alfalfa starts growing in the spring.

(Project B-79)

Study Effect of Herbicides on Plants

One of the newer herbicides being recommended for weed control in corn is Atrazine. In order to learn more about this herbicide concerning absorption, translocation and effects on plants, greenhouse studies were conducted with bean plants. It was found that this material will enter the leaves but will not move out of the leaf to any degree. The leaf will drop off, and the plant remain unharmed unless too many leaves are treated. When applied to the stem of a bean plant, the material is absorbed but moves in an upward direction only. This evidence and the injury pattern of the leaves indicated that it moves in

the transpiration stream of the plants. This herbicide is also apparently not taken up through cut leaves of barley or corn plants.

Another herbicide of interest, EPTC, was tested to determine the effects of its vapors on seeds. When applied to soils, it is thought to kill dormant seeds in the soil. In controlled tests, it was found that dry seeds are not affected but when the relative humidity is raised slightly, EPTC vapors will kill some seeds. There is also the possibility that the material is absorbed by the seed coat and retained until germination of the seed.

(Project B-80)

Work Continues on Giant and Yellow Foxtail Growth Characteristics

The study of giant and yellow foxtail growth characteristics was continued. Since both of these weeds are major weed problems in Maryland, a detailed knowledge of their life cycle will aid in controlling them. Both germinate in the spring and then follow a typical sigmoid growth pattern through the summer. In a study of head development, giant foxtail was found to develop viable seed 12 days after the heads emerged from the boot, yellow foxtail after 18 days. Yellow foxtail can emerge from seed planted as deep as 4½ inches, but giant only from 3½ inches. When foxtail is found in a corn or soybean field, it is cultivated out. However, it was found that if cut-off stems were replanted in moist vermiculite, approximately 75% of them would form roots and continue to grow.

Seed samples of each species were collected from many locations in Maryland in 1958. In 1959, these were planted and the resulting plants compared. There were found to be wide variations between the types within each species; both with regard to their physical appearance and growth habits and with regards to their susceptibility to the herbicide dalapon. Some were quite susceptible to the chemical, others relatively resistant. It was felt this might help explain some of the difficulties encountered in controlling these species in Maryland.

The tops, roots and seed of yellow and giant foxtail were extracted in water and then the extract used as the source of water for germinating alfalfa and timothy seedlings. All parts were found to have some inhibitory effect on

the seedlings, but the effect was particularly severe with extracts of the foliage. Work is continuing on this inhibi-

tory effect of the foxtails.

(Project B-70)

Search for Cheaper, More Effective Weed Control

Work was continued in the past year in an effort to find the best methods for farmers to use to control weeds in corn, soybeans, turf and field-planted tobacco. Work was also done on the control of German knotgrass and on Johnson grass. Several pre-emergence crabgrass killers were evaluated in turf. Dacthal (Rid) and Zytron showed particular promise. Some other experimental materials including chlordane were less satisfactory. When chlordane was used immediately before or after the seeding of bluegrass in March, it was found to severely inhibit the growth of the bluegrass. However, ryegrass seeded at the same time was able to make some growth in spite of the chlordane.

Many experimental materials are being produced annually in an effort to find satisfactory pre-emergence weed control killers for use in soybeans. The present materials (Dinitro and Randox) will usually do a satisfactory job but do not last through the entire season. Of the many materials that were tested in 1959, Amiben, Dacthal, Zytron and Eptam looked promising. Amiben in particular was able to control the weeds through most of the season and resulted in a yield increase in the soybeans. Granular and liquid forms of the various herbicides were compared and in general, the granular forms were just as good as the liquid forms.

In corn when control of annual weeds is needed through the entire growing season, Simazine and Atrazine seem to be best. In 1959, as in the past, these materials were the outstanding herbicides. They were used in both the

granular and spray forms and the granular forms did not appear to be quite as satisfactory as the spray forms. Cultivation of band treatments of these herbicides did not particularly reduce the weed control obtained. Other experimental herbicides in corn showed considerable promise but none of them looked as good as Simazine and Atrazine. Work was carried out at the Agronomy-Dairy Research Farm near Ellicott City on nutgrass control in corn. Here again, Atrazine used as an early post-emergence treatment resulted in 100% control of all nutgrass foliage for the year. Amino triazole, Dinitro and Eptam were not as satisfactory. Work is also continuing on this phase of the project.

Several materials were compared as pre- and post-transplanting herbicides in tobacco. Trietazine, a herbicide related to Simazine, resulted in very satisfactory weed control without injuring the tobacco, particularly when it was used just before field planting of the tobacco. Tobacco from plots treated with Trietazine yielded a higher dollar per acre return than tobacco from other plots.

German knotgrass in barley was partially controlled with an early winter treatment of Dinitro. However, if the Dinitro rate was excessive, the barley was severely injured. Johnson grass control experiments were continued and it was found that pre-emergence Eptam did not control established Johnson grass plants. Two post-emergence treatments of Dalapon again looked very good and post-emergence treatments of Fenac showed some promise.

(Project B-78)

When to Graze Summer Annual Pasture?

Many farmers in the state rely on summer annual pastures to carry their livestock during the hot, dry periods when most other pastures are dormant. There is a lack of information, however, on just when to begin grazing these pastures or how severely to graze them in order to provide the greatest seasonal yield.

A study has been undertaken to find the best time to begin pasturing Sudan-grass, Pearl millet and the newer Sudangrass-sorghum hybrids. The study also aims to determine just how much stubble should be left after each grazing, and how much nitrogen fertilizer will give the most economical results.

(Project B-82)

Method Developed for New Soil Tests

A method of following the addition and removal of cations from soil clays is being developed. By this method step-wise cation addition and subtraction can be followed, permitting an insight into the possibility of differential activity of ions on clays at various saturation levels. It also demonstrates the difference in behavior of the various types of clays and permits the study of some interesting and important phases in the availability of elements to plants.

A limestone test previously developed at Maryland is at present being studied by six laboratories. It has been found to do well in characterizing limestones to be used for liming. Actually, the test indicates that calcitic-type stones are more reactive than dolomitic-type stones of the same fineness. Although reactivity varies somewhat with size of stone, test results are much more closely related to actual field results than is screen analysis.

(Project O-55)

Sodium Nitrate Suggested for Ammonia-Fixed Soils

The entrapment of any ammonium-type fertilizer by the soil in such manner that the nitrogen of the applied fertilizer is not available to plants is known as ammonium fixation. There are a few of these fixing soils in Maryland. The most notable is the Myersville which surfaces much of the Middletown Valley. It has been noted that fixation in virgin soils is strongly expressed in the subsoil, whereas it may

be nearly absent in surface soil. In the case of the hilly Myersville soil, many years of farming have resulted in the loss of much of the topsoil, so the fixing tendency of this soil has been accentuated. To obtain on such soils efficient nitrogen utilization by crops and good crop production, the use of sodium nitrate as the nitrogen carrier in fertilizers is suggested.

(Project O-57)

Can Nitrogen-Fertilizer Grasses Replace Grass-Clover Mixtures?

With the present economical supply of nitrogen fertilizer available, it may be feasible to consider the establishment of pure grass pastures rather than depending upon legumes as a source of nitrogen. Nitrogen fertilized grasses also might provide good pasture in situations where the clover has been lost.

An evaluation of such pastures is

now underway as a cooperative Dairy-Agronomy study with orchardgrass, under three rates of nitrogen, being compared with a mixture of orchardgrass and Ladino clover. Midland Bermudagrass with sod-seeded cereal rye is also being evaluated for dairy cows in this study.

(Project BG-1)

Develop Ways to Determine Varietal Purity in Alfalfa

Practical benefits from breeding programs can be realized only if genetically pure and properly identified seed of improved varieties is maintained and made available. Procedures for determining varietal purity, therefore, are necessary. This project is designed to study field-planting techniques that will show the extent of variability in observable or measurable plant characteristics.

Space and row plantings in the field for four alfalfa varieties have been effective in evaluating differences in plant type. Clipping treatments have given promise as a further means of varietal differentiation beyond that provided by the more obvious plant characteristics. Further work is needed.

(Project B-72)

New Management Systems Produce High Yields of Quality Alfalfa

The full potential of new varieties of alfalfa can only be realized when the best management is used. Results have demonstrated that forage quality is drastically reduced as the spring harvest time is delayed from the full bud (when the first blooms appear in the field) to the 1/10 bloom stage of growth. Harvesting earlier than full bud has not substantially improved forage quality. When both annual yield and quality are considered over a five-year period, making the first harvest at full bud and remaining harvests at 1/10 to 1/2 bloom has proved superior.

Early bud harvesting throughout the season has reduced stands, but limiting it to the first harvest in the season has not significantly reduced stands.

No reduction in stand has been measured when alfalfa fields were harvested near the time of the first killing frost in the fall. Moreover, this practice has resulted in $\frac{1}{2}$ to 1 ton more forage per acre. Stands were reduced, however, when harvests were made two to three weeks prior to the first killing frost as well as when an excess of mature forage was left standing over winter.

(Project B-56-n)

Synthetic Varieties of Orchardgrass Near Final Evaluation

Clones and polycross progenies of orchardgrass have been evaluated at several agricultural experiment stations of the northeast, including Maryland. Synthetic varieties have been formulated on the bases of both regional and local performance. These new varieties will be established during the fall of

1960, to be evaluated for the next several years. Such tests will yield information on: (1) the feasibility of the orchardgrass regional breeding programs; and (2) the adaptability and agronomic performance of the new synthetic varieties.

(Project B-56-i)

Hill Soybeans Released to Maryland Farmers

Hill, a new soybean variety superior in seed yield and disease resistance, was released to Maryland farmers July 15, 1959, as part of the Cooperative Uniform Soybean Tests by the U.S. Department of Agriculture and state experiment stations. Hill, approximately the same maturity as Dorman, exhibits

resistance to bacterial pustule, wildfire, and frogeye, all major diseases of soybean foliage and Phytophthora, a root and stem rotting fungus. Hill has been high in seed-yielding abilities and has good resistance to lodging, the purple stain fungus and root-knot nematode.

(Project B-43)



An attempt is being made to produce true F_1 double crosses of Ladino clover.

Initiate Studies of Ladino Clover

A series of experiments was initiated with Ladino clover to answer urgent questions arising with this species. What environmental factor or factors are responsible for lack of persistence in Ladino clover? Will it be possible, theoretically and practically, to produce

true F_1 double crosses in Ladino clover? Will the world supply of Ladino and white clovers furnish valuable materials for future breeding programs? Answers to these questions and others are being sought in new studies with the species. (Project B-56-g)

Secure More Information on Management of Pure Grass Stands

During recent years there has been an increased interest in the use of pure grass stands rather than grass-legume mixtures. This interest has been stimulated by low-cost nitrogen, reduction of bloat problem with pure grass and the fact that pure grass stands are easier to maintain. Although the use of nitrated pure grass stands eliminates some forage management problems, it creates new problems that must be answered if efficient production and utilization are to be realized.

In order to obtain answers to some of the management problems involved in the use of pure grasses under high nitrogen fertilization, a study was ini-

tiated in the fall of 1959. The objective of the experiment was to determine the influence of cutting frequency, cutting intensity and nitrogen fertilization on the productivity, persistence and quality of pure grass stands. The grasses being studied are Pennlate orchardgrass (late maturity), Potomac orchardgrass (early maturity), Saratoga bromegrass and Common reed canarygrass.

Preliminary data indicate that early boot harvest of these tall-growing grasses results in better aftermath production than when the grasses are allowed to reach maturity before being harvested. (Project B-73)

New Pasture Combinations Result in High Beef Production

Livestock numbers continue to increase in Maryland with the result that total feed needs are high. Good pastures are the most economical source of livestock feed. This is extremely im-

portant since feed costs make up a large part of the costs of producing livestock products. During the past three years, a new pasture combination for beef cattle (Midland Bermudagrass

sod-seeded with rye) has been tested in the Coastal Plain area of the state. The average beef production per acre per year for this pasture has ranged from 546 to 750 lbs. per acre with a three-year average of 668 lbs. per acre. The next best pasture mixture produced an average of only 406 lbs. In addition to a longer grazing season of 30 to 60 days, the Midland-rye com-

bination has had a significantly higher animal carrying capacity per day during the grazing period. Although individual animal performance on the various pastures varied considerably, this combination was surpassed only by Kentucky bluegrass, was equal to orchardgrass and was superior to reed canary-grass pastures.

(Project B-56-j)

Breed for Mildew Resistance in Wheat

A good beginning seems to have been made in transferring mildew resistance to the progeny of locally adapted but susceptible varieties. Almost 500 space-planted F_3 progeny rows from 21 susceptible x resistant wheat crosses were grown in the nursery adjacent to spreader rows of a susceptible variety. Although only moderately heavy, nat-

ural infection seemed adequate to provide differential readings. Susceptible parents showed from 15-40% infection and resistant parents, from 0 - 2%. Clean F_3 progeny plants from the 21 crosses were harvested for further multiplication and study.

(Project B-69)

Evaluate Method of Breeding Red Clover

Maternal line selection in red clover has been in progress at the Maryland Agricultural Experiment Station for the past 10 years. A recent evaluation of the progress attained by this method indicated some improvement in per-

sistence, but not the degree of persistence that is desired in this species. Several clones have been identified as resistant to powdery mildew.

(Project B-76)

Breeding behavior of superior red clover clones is under investigation. Greenhouse facilities insure maintenance of selected plants for many years.



Sod-Seeded Forages Supplement Existing Permanent Pasture

With the use of a productive summer-growing perennial such as Midland Bermudagrass, there has developed a need for supplemental spring and fall pasture to be used along with the Midland. Under many conditions, this need can best be met by utilizing existing Kentucky bluegrass pastures or by establishing orchardgrass-ladino clover plantings for that purpose. However, if acreages are short and maximum production per acre is desired, the practice of sod-seeding a winter annual directly in the undisturbed Midland sod looks very good. This practice has greatly increased beef production per acre as well as total forage production. Experiments are now underway to determine the optimum seeding rate, row spacing fertilization and

early seedling management of the sod-seeded crop. Preliminary results indicate that close row spacing (8-10 inches), high seeding rates (90-180 lbs. per acre) and high nitrogen (60-90 lbs. per acre) will give the highest total production as well as good forage distribution. Of the seven species studied, cereal rye and hairy vetch were the most productive. The rye produced forage in the fall and early spring months while vetch produced most of its forage in the late spring. The combination of these two species looks very promising.

Techniques of re-establishing small-seeded legumes in existing cool-season pastures are being investigated. This has met with varying degrees of success.

(Project B-75)

Midland Bermudagrass Yields Well with Nitrogen Fertilization

For many years research workers have been searching for pasture species or mixtures that would produce more forage during the summer months of July and August. The need for extra pasture during this period has been met in the past through the use of summer annuals such as sudangrass, pearl millet or lespedeza. The introduction of Midland Bermudagrass into this area has opened up a completely new field with regard to summer pasture production.

The rate of nitrogen to be applied and the frequency of harvesting Mid-

land are being studied in detail. Forage production with this grass during the past year varied from 1.46 tons of dry matter to 7.97 tons of dry matter per acre, depending on the nitrogen application and frequency of harvest. The response to nitrogen appeared to level off at between 200 and 400 lbs. of nitrogen per acre, with an increase in forage production as the number of harvests were decreased. The forage quality appeared to be better with the more frequent harvests and higher nitrogen rates.

(Project B-74)

Study Timing, Method of Applying Fertilizer to Alfalfa

A fertilizer study is in progress on alfalfa being grown on Beltsville silt loam, a Coastal Plain soil of moderate fertility with little fixing capacity for phosphorus and potassium. In this test fall applications of 0-10-10 fertilizer have proved as effective as spring applications. A three-fold application of

0-10-10 once in three years maintained yields very well. It is concluded that knowledge of the fixing capacity of a soil is important in making recommendations for rate, time and frequency of application.

Although the use of higher rates of fertilizer on corn in recent years has

promoted the band placement method — 2 inches to the side and 2 inches below the seed — the question often arises as to the possible value of using the shallow split-boot application to supplement broadcast application. In one comparison, 1000 lbs. per acre of 10-10-10 was applied as follows: (1) 200 lbs. through the split boot, 800 lbs.

broadcast; (2) 200 lbs. in the band, 800 lbs. broadcast; (3) 1000 lbs. in the band. Forty days after planting, corn on the split-boot plots was well ahead of the other two in plant growth. Split-boot application may continue to have a place under certain conditions.

(Project O-62)

Grain Production Not the Only Use for Wheat

Although the wheat acreage is decreasing in Maryland, the crop is still important to many farmers from the standpoint of grain, straw, winter cover and nurse crops. It is important to maintain the efficiency of the crop for all of these purposes. To this end, breeding and evaluation work is in progress.

Varieties with stiffer straw, more dis-

ease resistance and better performance at high fertility levels are in the making. The large straw growth usually occurring at high fertility levels encourages damage from mildew. Under these conditions mildew resistance is especially important. Mildew resistance is being bred into adapted local varieties.

(Project B-66)

Search for Improved Barley, Oat Varieties

Barley and oats are important feed grains in Maryland. In 1960 it was estimated that these two crops were harvested from 146,000 acres. With better varieties it is likely that these two crops would replace more wheat in the state. Work is in progress to find varieties that combine consistent productivity, disease resistance, stiff straw, tolerance to late planting, and in the case of barley, varieties without awns or with

awns that are easily removed in harvesting. Unusually cold weather early in the fall after seeding caused much cold injury to the 1959 crop. Good readings for cold tolerance in both winter barley and winter oats were obtained. A few barley selections including the variety, Piedmont, were severely damaged. In the case of winter oats survival was less than 20% for most test entries.

(Project B-67)

Corn Improvement Continues

The proportion of superior hybrids in each maturity group has been increasing year by year. Maryland farmers in all sections of the state now may choose from a list of hybrids with good performance records. (See Misc. Pub. 380)

Field tests continue to emphasize the relationship between yield and growth period requirement. As a group, full season (late) hybrids planted early pro-

duce more dry matter per acre than do short season (early) hybrids, regardless of the planting date of the latter.

Although much progress has been made in eliminating hereditary weaknesses, the job is not finished. Corn breeders in the Northeast are now concentrating on finding more stalk rot resistance. The Maryland Station is participating in this effort.

(Project B-50)

Grain Sorghum Hybrids Show Drought Tolerance

Field tests were continued on grain sorghum hybrids in comparison with sorghum varieties and with Ohio W64 hybrid corn. One test was located on silt loam soil and another on sandy loam soil. A late drought limited yields in both tests but more so on the sandy soil. On the latter, the yields of all

sorghum hybrids equalled or out-yielded corn. On the heavier soil, corn at 92 bushels per acre was 13 bushels ahead of the most productive sorghum. In good corn seasons, OhW64 has been more productive than the sorghum hybrids on both soil types.

(Project B-71)

Determine Critical Potassium Contents of Alfalfa

Alfalfa has a high requirement for potassium. When this plant does not have enough potassium for proper growth, certain "hunger" signs are exhibited. These signs include reduction in yield, visual deficiency symptoms on the leaf and loss of stand. In an attempt to determine at what potassium levels these signs occur, various rates of potash were applied to alfalfa. The results demonstrated that deficiency symptoms and reduction in yield occurred when the alfalfa plant con-

tained less than 1.6% K. Loss of stand took place when the K content of alfalfa dropped to 1.2% or below. In this experiment, somewhere between 100 and 200 pounds of potash per acre per year were required to keep the potassium level of the plant above 1.6%. Higher yields of alfalfa were obtained when the above rate of potash was applied just after the first cutting than in the fall, early spring or in split applications.

(Project O-60)

Evaluate Forage Crop Varieties

Variety tests with many species are conducted at selected locations throughout the state to identify the most adaptable and best-performing varieties of forages for the various areas of the state. DuPuis alfalfa has been especially productive in Piedmont and Coastal soils. Chesapeake red clover continues to be the best among many strains and exhibits a marked superior-

ity in seedling establishment in some environments. Summer annual grasses displayed a diversity of material in regard to maturity and disease resistance: sudangrasses appear most desirable to date. Midland bermudagrass continues to exhibit a marked superiority over all other bermudagrasses.

(Project B-77)

Test Effects of Soil Temperature on Forage Species

It has long been recognized that some crops grow better and produce higher yields than other crops during the hot dry summer months. In an attempt to learn more about the effects of environment on plant growth, many crops have been grown in controlled growth chambers. It is extremely difficult to dupli-

cate field conditions in these growth chambers. Attempts to measure environmental conditions and relate them to plant responses have met with only limited success since it is difficult to separate individual effects.

Many of the difficulties associated with the growth of some of our impor-

tant forage species are directly or indirectly associated with soil temperature. Attempts are being made to characterize these effects by growing a series of

species in the field where different soil temperatures will be maintained throughout the growing season.

(Project B-83)

Nutrient Balance Improves Grass Yield, Quality

The importance of proper nutrient balance for plants has long been recognized. However, knowledge on the optimum amounts and ratios of various nutrients for pure grass forages is quite limited. To supplement present knowledge, various rates and ratios of nitrogen to potassium were applied to orchardgrass for two years. For the second straight year, a 2-to-1 ratio of nitrogen to potash has proven to be the most satisfactory ratio tested. Maximum yield (3.78 tons of dry matter per acre)

in 1959 was obtained with 200 pounds of nitrogen and 100 pounds of potash per acre. The protein content of the forage at this rate was 17%. Nitrogen and potassium increased the percent recovery of one another when applied in the ratio of 2 nitrogen to 1 potash. Potassium deficiency symptoms on orchardgrass, receiving little or no potassium, appeared sooner and more severely when high rates rather than low rates of nitrogen were applied.

(Project O-59)

Ammonium Nitrate—a Good Nitrogen Source for Grass Forage

As a source of nitrogen for bluegrass pasture, NH_4NO_3 appears to be generally as good as or better than any other source tested [$(\text{NH}_4)_2\text{SO}_4$, urea, urea-formaldehyde]. In some instances urea proved to be superior to NH_4NO_3 , but an overall evaluation of results favored NH_4NO_3 . Although yields were low in 1959 and were not greatly different due to nitrogen source, use of NH_4NO_3 resulted in the highest protein forage (urea, in the wetter

year of 1958, caused the highest protein forage). The data of this experiment show that split applications of nitrogen as NH_4NO_3 or urea are better than single applications, particularly in a "wet" year. The data also indicate that total applications of 80 to 160 pounds of nitrogen per acre will give the most economical bluegrass yields. The residual effect of these fertilizers, particularly urea-formaldehyde, will be evaluated in 1960. (Project O-61)

ANIMAL HUSBANDRY

Research in animal husbandry is planned to assist livestock raisers in producing meat animals more efficiently. The results of the research vary in the immediateness of their application, and a balanced program is attempted by staff members.

In a report of this nature, only a resume of some of the more important work can be given. More detailed information is made available in scientific papers, bulletins and popular articles released by the department. Findings are also presented to the public in other ways, such as at field days, short courses, in news and radio releases, etc., in cooperation with the Extension Service whenever possible. In these ways, research results may be given producers and consumers as quickly as possible.

Research projects are conducted in close cooperation with other departments of the University having a mutual interest, other state experiment stations, the U.S.D.A., local packing houses and livestock farmers.

Study Volatile Fatty Acid Production

It is now well established that the volatile fatty acids (VFA) produced in the rumen through microbial fermentation of carbohydrates make up a major source of the energy available to ruminant animals. Most of the VFA are acetic, propionic, butyric and valeric acids, the first two making up about 80 percent of the total molar concentration of acids. It is also known that diet can markedly affect acetic-propionic acid ratios and that the relative amounts of these two acids can be of considerable consequence to the animal. For example, animals on roughage rations have a preponderance of acetate in the rumen, while those on high concentrate diets show higher concentration of total VFA and a shift to higher percentage of propionate. It is known that propionic acid is used more efficiently by the ruminant than is acetate. The higher value of digested concentrates when compared to digestible nutrients from roughages can probably be explained by differences in the VFA produced.

Studies to gain more information about VFA production and utilization are being conducted. As reported last

year, a surgical technique for an isolated rumen pouch for VFA absorption and fermentation studies has been developed. Data on VFA absorption from the pouch indicate that absorption rates reflect the concentrations found in the rumen contents. *In vitro* and *in vivo* studies conducted here and at many other stations indicate that production of VFA is also reflected in the rumen concentrations. Thus, information on both absorption and production indicate that rumen fluid analyses are a reliable index to the nature of the rumen fermentation as indicated by ratios and concentrations of VFA, and the relatively simple procedure of rumen content analysis can be used to study effects of diet and other factors upon rumen function.

If a rapid rate of fermentation of digestion and a high production of propionate in the rumen are desirable, it would appear worthwhile to examine possibilities of increasing fermentation rates. Several *in vitro* studies with C¹⁴ labelled glucose have been conducted. Results of these studies indicate that the concentration of glucose can influence the relative amount of propionate

produced; the higher the glucose concentration the more propionate relative to acetate, irrespective of the diet of the animal which was the source of the rumen fluid. Concentrates contain more starch and less cellulose (fiber) than roughages. Both starch and cellulose are glucose polymers (that is, made up of a number of molecules of glucose) and must be broken down to glucose or glucose derivatives before VFA are produced. A possible explanation for the high levels of propionate observed in the rumen contents of grain-fed animals is that the starch is rapidly digested and thus, a relatively large amount of glucose is available for VFA production at those times when starch is being fermented. The cellulose is digested more slowly, the relative concentration of glucose is lower and a higher percentage of acetate is produced from high roughage rations. If these observations reflect the true picture in the ruminant animal, it is obvious that the rate of digestion is important from the standpoint of VFA production as well as for such factors as passage time and feed intake. Fiber digestion has long

been recognized as an advantage of the ruminant animal. If more rapid digestion can increase the production of rumen propionate, the energy value of digested fiber should be enhanced, and the quest for factors that will speed up propionate production from fiber is justified.

Feeding studies involving the addition of small amounts of propionate to roughage diets are being initiated. One objective is to formulate diets with which small and predictable changes in rumen acetate-propionate ratios can be achieved so that the effects of such changes can be evaluated. Another objective of these studies is to create conditions which will result in increased propionate production from roughages. The establishment of "normal" fermentations of concentrates and roughages in the rumen pouch is also being attempted. Successful "digestion" in the isolated pouch will allow further separation and study of the animal, microbial and dietary factors which affect the fate of nutrients ingested by ruminants.

(Projects C-25 and C-21)

Continue Studies of Value of Pelleted Barley for Beef Calves

A second feeding trial on the value of pelleted barley for finishing beef calves was started in 1959. In the second feeding trial, 21 purebred Angus and Hereford creep-fed steers were started on feed on October 6, 1959. The steers were divided into two groups by breed, weight and age. They averaged 7.5 months of age and 473 pounds in weight at the start of the trial. The rations fed were the same as those fed the previous year (barley, alfalfa hay, soybean oil meal and minerals). One group received crimped barley and the other group was fed pelleted barley. The protein supplement was pelleted in with the barley at the rate of one pound of soybean oil meal to ten pounds of

barley. The same ratio was fed with the crimped barley. The average daily gain from October 6, 1959, to May 17, 1960 (224 days), was 2.25 pounds for the steers fed crimped barley versus 2.04 pounds for those receiving pelleted barley. Although these steers have not completed the feeding trial, the trend in rate of gain is similar to the 1958 test. In the 1958-59 feeding trial, the steers were fed for 252 days. The average daily gain for the steers fed crimped barley was 2.04 pounds versus 1.89 pounds for steers fed pelleted barley.

In addition to the steers fed in 1958-59, four lots of purebred Angus and Hereford heifers were fed crimped or pelleted barley for 196 days. Two

groups were fed crimped barley and two groups were fed pelleted barley. Heifers fed crimped barley gained 1.68 pounds per day versus 1.64 pounds for the pelleted barley groups. When the gains for the steer and heifer groups were combined, the three groups receiving crimped barley gained 1.80 pounds per day and the groups fed pelleted

barley gained 1.72 pounds per day. These gains were satisfactory, considering that the calves were creep fed from the time they were old enough to eat grain to weaning. The cost of gains was higher in the pelleted group due to the extra cost of pelleting the barley.

(Project C-31-a)

Compare Soybean Oil Meal and Commercial Feed Supplement

A comparison of a liquid commercial supplement versus soybean oil meal as a supplement for finishing beef calves was conducted over a two-year period.

In the second year, 15 purebred Angus and 12 purebred Hereford creep-fed heifers from the University's herds were weaned and started on feeding trial on October 7, 1959. One sire group of nine additional purebred Angus heifers, of approximately the same weight and age as the University heifers, was purchased and put on test with the University calves. The heifers were divided into four groups by breed, age, weight and farm. The rations fed in this feeding trial differed somewhat from those fed the previous year. For this feeding test all groups were fed crimped barley. Two groups were fed a low-protein grass hay and grass silage in accordance with the program recommended by the commercial feed supplement manufacturer, whereas the other two groups were fed a conventional, high-protein alfalfa hay. In the low-protein roughage group, one lot received soybean oil meal as the protein supplement at the rate of one pound to 6.2 pounds of barley and the other group had free access to the liquid commercial supplement in a tank. In the high-protein alfalfa hay groups, one lot received soybean oil meal as the protein supplement at the rate of one pound to ten pounds of barley while the other lot had free access to the liquid commercial supplement. All feeds and

mineral compounds were fed free choice.

In the low-protein roughage groups, the calves receiving soybean oil meal gained 1.48 pounds per head per day versus 1.43 pounds for those fed the commercial supplement. The consumption of barley and hay per day and per unit of gain was greater in the commercial supplement group. The average daily consumption of the commercial supplement was 1.27 pounds less per head than the soybean oil meal consumption. In the two groups fed the high-protein alfalfa hay, the average daily gain was 1.61 pounds for the calves fed soybean oil meal versus 1.62 pounds for those fed the commercial supplement. The commercial supplement group consumed less barley and more hay per day and per unit of gain than did the soybean oil meal group. The average daily consumption of the commercial supplement was 0.1 pound less per head than the consumption of soybean oil meal. Feed cost per unit of gain was \$1.51 per hundredweight less in the low-protein roughage group for the commercial supplement but \$.89 per hundredweight higher in the high-protein roughage group.

When the two years' work was combined, the average daily gain for the soybean oil meal groups was 1.61 pounds versus 1.57 pounds for the liquid commercial supplement groups. The soybean oil meal group consumed less total barley and roughage than did the

commercial supplement groups. The soybean oil meal groups required 49 pounds less barley per hundredweight gain and 30 pounds less roughage. The soybean oil meal group consumed more total protein supplement, 37 pounds more per hundredweight gain, than did the commercial supplement groups. However, it must be noted that the commercial supplement was free choice whereas the soybean oil meal was fed

mixed with the barley.

From these results it appears that the commercial liquid supplement may be more economical when used with a low-protein roughage; however, the overall cost may be higher when the supplement is fed with a high-protein roughage. The commercial liquid supplement does have an advantage with regard to ease of feeding. (Project C-31-b)

Pelleting Improves Hays for Breeding Ewes

During recent years there has been an increasing interest in the grinding and pelleting of hays for sheep. Several studies with fattening lambs indicate that pelleted hays result in increase forage intakes and improved gains and feed efficiencies. The work to be reported here deals with the feeding of pelleted hays of varying qualities to breeding ewes. Ground, pelleted alfalfa, timothy and orchard grass hays have been compared to similar hays in the long form. The quantities of pellets fed have been limited in an attempt to determine if pelleted roughages have nutritional values other than those which can be attributed to increased feed intakes. Pellet consumption has been held to less than 3.0 pounds per 100 pounds bodyweight per day while long hay consumption has been *ad lib.* and has averaged approximately 20 percent more than the pellet allowances.

Long alfalfa hay is satisfactory as the only feed for ewes in late pregnancy but can be considerably improved by pelleting. In two trials Hampshire ewes in late pregnancy consumed an average of 4.9 pounds of alfalfa hay with an average daily gain of 0.40 pound, while an intake of 4.1 pounds of pelleted alfalfa resulted in 0.66 pound gain. Southdown ewes gained 0.32 pound per day on 4.3 pounds of hay and 0.40 pound on 2.9 pounds of pellets. Five to 7 percent of the long hay offered was

refused; there was no waste with the pellets.

Timothy hay of fair to poor quality (4.7% crude protein, 37% fiber) was not satisfactory for pregnant ewes in the long form. Hampshire ewes consumed 4.6 pounds of such hay with a gain of 0.24 pound per day, and Southdown ewes failed to gain weight or maintain condition on an average hay intake of 3.3 pounds. Three and seven tenths pounds of timothy pellets resulted in 0.37 pound gain for Hampshire ewes, and Southdown ewes gained 0.24 pound per day on 2.8 pounds of timothy pellets. Approximately 20 percent of the long timothy offered was refused, and there was considerable waste.

Pellets made of a mixture of 75 percent orchard grass hay and 25 percent alfalfa hay also appear superior to long hay offered in the same ratio. Southdown ewes failed to gain on the long hay while 3.0 pounds of pellets resulted in a 0.33 pound gain; 4.8 pounds of the long hay was offered and only 3.2 pounds were consumed.

Analyses of refused hays, as compared to what was fed, indicate that the sheep, as could be expected, consume the more desirable parts of the hay plants and refuse the stemmier high-fiber parts. Pelleting insures the consumption of all the hay. It can be calculated that nutrient intake was higher on the long hay

than on the pellets in these experiments and that the value of the pellets cannot be explained on the basis of feed intake.

Analyses of rumen contents of ewes on long hay and pellet diets show that pelleting results in a higher concentration of total organic acids in the rumen, and there is an increase in the percentage of propionic acid present. Total rumen propionic acid increased by an average of about 50 percent in the pellet-fed animals. It is known that propionate is utilized more efficiently than acetate as an energy source for ruminants and that total acids in the rumen reflect the rate of digestion. It appears

that pelleted hays are more rapidly digested in the rumen than similar hays in the long form, and thus, the benefits of pelleting are due, at least in part, to the more rapid rate of rumen fermentation.

It should be noted that the rumen contents of sheep on long alfalfa hay contained more total acids and more propionic acid than did those of sheep on pelleted timothy or orchard grass hay. Although poor quality hays may be markedly improved by pelleting, they fail to compare with high quality hay which is also more valuable when pelleted.

(Project C-25-a)

Evaluate Worming Compounds for Swine

Internal parasites are responsible for large losses to swine producers every year. It is estimated that the large round worms, commonly known as ascarids, cost swine raisers of the United States an estimated 50 million dollars a year. Ascarids damage the health of pigs in many ways. Young ascarids passing through the lungs injure them severely and may cause pneumonia. In severe infestations, many young worms in the lungs contribute to spasmodic coughing or thumps. Young worms passing through the liver produce injuries where small whitish scars develop. Livers that have been severely damaged by young ascarids contain many scars and are unfit for food. The presence in the intestines of many mature ascarids, which may reach the length of one foot, can cause a reduction in growth rate and feed efficiency. Nodular worms and whip worms also cause losses to swine producers but are less important than the ascarids.

Good management and sanitation programs aid in the control of internal parasites in swine. However, there frequently is a need for a worming agent to eliminate and control the parasites. A series of six trials has been conducted

during successive seasons to evaluate the effectiveness of various worming compounds.

It was observed that healthy, vigorous pigs that were relatively free of parasites at eight weeks of age showed considerable natural resistance to infestation thereafter. It also was suggested that worming treatment of much of the swine herd during a period of three years has resulted in a lower level of infestation for control animals.

The worming compounds tested were sodium fluoride, cadmium anthranilate, hygromycin B (Hygromix), insoluble piperazine CS₂ (Parvex), soluble piperazine CS₂ and piperazine dihydrochloride (Verban).

Sodium fluoride was very effective in the removal of ascarids. In each trial that it was tested, sodium fluoride treatment resulted in the complete or nearly complete elimination of ascarid infestation. However, the depressed rates of gain and feed efficiencies that accompanied this treatment impose limitations on its general usefulness. Of the compounds tested, only sodium fluoride had a depressing effect on gains and efficiencies.

Cadmium anthranilate was found to

be approximately 50 percent efficient in the removal of ascarids and produced no undesirable side effects.

The piperazine compounds tested appeared to be between 90 percent and 100 percent efficient for ascarid removal when administered in the feed. Piperazine dihydrochloride was effective when administered in water, but the soluble piperazine CS₂ was not consumed in large enough quantities to be effective.

The continuous feeding of 600 units of hygromycin B per pound of feed was also 90 percent to 100 percent effi-

cient in the removal of ascarids at moderate levels of infestation. It had no apparent effect under conditions of very minor infestation. In two trials there was a small improvement of feed efficiency for pigs treated with hygromycin B.

The levels of whip worm and nodular worm infestation were not high enough to be considered significant. Therefore, comparisons of the compounds for control of these parasites have been inconclusive.

(Project C-24)

Study Feeding Methods for Lean Pork Carcasses

Consumer preference for meat with less fat and a decline in the demand for lard have stimulated investigations to develop methods for producing leaner swine carcasses. Considerable progress has been made in locating and selecting breeding animals whose progeny are the desired "meat type" hog. Continued development and application of our knowledge of breeding is necessary. In addition, the development of feeding methods to improve further the carcasses of the "meat type" hogs can increase consumer acceptance of pork products.

During the past year, studies of the effect of energy consumption on swine carcasses were continued.

Three lots of ten pigs each were individually hand fed twice daily to enable more exact measurement of feed consumption and to regulate nutrient intake more accurately. Those pigs which served as controls were fed as much as they would consume of a 15 percent protein ration during the growing period and a 12 percent protein ration during the finishing period. The calculated net energy was 76.5 thermals for the 15 percent ration and 76.8 thermals per hundred pounds for the 12 percent ration. Two additional rations

for each feeding period were formulated to provide similar intakes of protein, vitamins and minerals when less feed was offered to reduce energy intake by 20 percent or 30 percent. The reduction of energy intake was accomplished by removing corn (a high energy, low protein feed) from the ration. When the control animals reached an average weight of approximately 200 pounds, all animals were slaughtered and carcass measurements were taken. The carcass measurements included back fat thickness, body length, loin eye area and individual weights on each of the wholesale pork cuts.

Full-fed pigs gained more rapidly than pigs on a reduced energy intake. However, rate of gain was not an indication of efficiency or composition of gain. Full-fed control pigs consumed 0.4 of a pound more feed per pound of gain and 1.0 pound more feed per pound of lean cuts produced. The efficiency of protein utilization was approximately the same for control pigs and those whose energy intake was reduced 20 percent. A 30 percent reduction of energy intake resulted in less efficient protein utilization.

The pigs which consumed 20 percent or 30 percent less energy produced

approximately the same total quantity of lean cuts during the same period of time. The average backfat thickness and the weight of leaf fat were also consistently lower for pigs on the reduced energy levels. And these pigs also had loin eye areas equal to or greater than those of the control pigs. It should be noted, however, that pigs which consumed 30 percent less energy than the full-fed controls produced watery carcasses that lacked desirable quality.

The results of this and a previous trial suggest that greater economy of pork production in terms of nutrient utilization may be achieved while im-

proving carcass quality by reducing the energy consumption of pigs. A reduction of 20 percent from the consumption of full-fed pigs appears to be most desirable. The consumption of protein, minerals and vitamins must be similar to that of animals feeding according to appetite to obtain these results. It has been shown that lighter pigs fed on a reduced energy level provided approximately the same amount of lean cuts. This would eliminate the need for meat packers handling more low priced fat per pound of lean meat merchandized.

(Project C-26)

Copper Sulfate Increases Swine Growth Rate

Previous trials at Maryland and other stations have suggested that the addition of copper sulfate to rations for growing-finishing swine at levels less than 0.1 percent improves performance. The nature of the response to copper sulfate also indicated that its activity might be similar to that observed in the presence of antibiotic additions. Since levels of copper slightly higher than the amount provided by 0.1 percent copper sulfate have been reported as toxic to swine, levels of copper sulfate addition approaching 0.1 percent were studied for possible toxic effects and growth responses during the past year.

Rations containing 0, 50, 75 and 125 parts per million of added copper in the form of 0.4 pound, 0.6 pound and 1.0 pound of copper sulfate per ton were fed to eight lots of four pigs each in a summer trial. The trial was started when the average weight of the pigs was approximately 50 pounds and was terminated when they had reached an average weight of approximately 190 pounds.

No toxic effects of the added copper sulfate were noted, while some favor-

able responses to the levels studied were indicated. The average daily gains were as follows: no copper sulfate, 1.41 pounds; 0.4 pound of copper sulfate, 1.34 pounds; 0.6 pound copper sulfate, 1.63 pounds; and 1.0 pound of copper sulfate, 1.61 pounds. Those pigs which received the ration with the highest level of copper sulfate addition were the most efficient in conversion of feed to gain. They required 0.2 pound less feed per pound of gain than the pigs that were offered rations at the zero and 0.6 pound of copper sulfate per ton level. Pigs which received 0.4 pound of copper sulfate per ton of feed were not as efficient as the control animals.

These results suggest that levels of 100 to 125 parts per million of added copper in swine rations are not toxic. The responses observed have been similar to those noted when antibiotics were added to swine rations; i.e., an increase in growth rate with minor improvement of feed efficiency. Levels of added copper sulfate less than 0.8 to 1.0 pound per ton of feed have not produced consistent results.

(Project C-27)

Study Effects of Pelleting Rations for Swine

A study of the effect of pelleting on swine rations has been continued. Supplemented rations containing either corn or barley as the only grain have been compared in the form of meal or pellets. The objectives in these studies have been to determine whether or not either ration is improved by pelleting and the relative values of the rations in either form.

During the past year, rations of similar crude protein content, containing either corn or barley as the only grain, were fed to growing-finishing swine. The rations were evaluated on the basis of the rate of gain that was supported, feed efficiency and the cost per 100 pounds of gain.

Pigs which were fed the pelleted barley-containing ration consumed 0.2 pound less feed per pound of gain and gained at a faster rate than pigs fed the same ration in meal form. The daily feed consumption was also higher for pigs that were offered the pelleted barley-containing ration. No advantage for pelleting the corn-containing ration was demonstrated. When compared to the pelleted ration containing barley, feed consumed per pound of gain was 0.25 pound less for the corn meal ration and 0.22 pound less for the corn pellet ration. The rates of gain for pigs fed the corn-containing rations were approximately the same as for the pigs offered the pelleted ration containing barley.

The trend for differences in growth rate and feed efficiency appeared during the growth period to 125 pounds, but was more marked in the finishing

period from 125 to 200 pounds. Pelleting a ration containing barley appears to improve its palatability and efficiency of utilization for swine. No similar improvement has been demonstrated for a corn-containing ration.

The feed costs per 100 pounds of gain for the different rations were:

1. corn, meal	\$9.87
2. barley, pellet.....	10.41
3. barley, meal	10.59
4. corn, pellet.....	10.68

If a swine producer raises 100 pigs and each pig gains 160 pounds from weaning to market weight, the crop of pigs would gain 16,000 pounds. The cost of 160 hundredweights of gain for each ration would be:

1. corn, meal.....	\$1,579.20
2. barley, pellet.....	1,665.60
3. barley, meal	1,694.40
4. corn, pellet.....	1,708.80

The difference of \$129.60 between the corn meal and corn pellet rations appears to be of economic significance.

A charge of \$4.00 per ton for pelleting was included in the calculation of feed costs; however, lower charges have been quoted for large volumes of feed. A high cost of pelleting can cancel out other economic advantages of pelleting barley rations. Economic factors involved in feed handling and not nutritional advantage should determine the advisability of pelleting corn-containing rations for growing-finishing swine.

The price of barley is frequently more favorable relative to corn than was true for the price used in the above computations.

(Project C-28)

BOTANY

The Department of Botany is committed to applied and fundamental research, as related to agriculture in Maryland. As may be noted in the following reports of research activities in the Department, certain of the projects are concerned with and contribute to both the fundamental and applied aspects of agricultural problems.

Establish Genetic Control of Haploids in Peppers

Experiments establishing the genetic control of haploidy in pepper have been completed. Twin seedlings with haploid members occur infrequently in most varieties of pepper. However, one genetically uniform line of pepper produced an unusually high frequency of twin seedlings with haploid members (approximately 3%) after self-pollination. The high frequency was maintained following crosses with pollen from lines of pepper characterized by

low frequencies of haploidy. The recently completed analysis of a large population of individual seedlings and twin seedlings disclosed that the high frequency line did not increase the occurrence of haploids when utilized as the male parent. These results show that the heredity constitution of the female parent determines the incidence of plants with a single set of hereditary factors in pepper. (Project F-15-b)

X-Ray Upsets Pepper Pollen Chromosome Pairing

In normal sexual reproduction, each parent contributes one of every kind of chromosome to the next generation. In order for the next generation to be fully fertile, the chromosomes must organize into bivalents or pairs of like chromosomes prior to the formation of the sex cells. Consequently, the association of all of the chromosomes into pairs is fundamental to normal seed production. Preliminary observations of sterile plants from the first generation

following X-irradiation of the pollen of pepper disclosed asynapsis or the failure of the chromosomal complement to organize into pairs. The X-ray dosages employed were not sufficient to cause alterations in all the chromosomes showing asynapsis. Apparently, an X-ray induced alteration in one chromosome can interfere with the ability of other chromosomes to associate normally as pairs. (Project F-16)

Maneb Increases Tomato Yield

Data from experiments with the tomato variety KC146 show that eight applications of maneb increase the yield of tomatoes by more than 5 tons per acre.

In laboratory studies, it was shown that the antifungal antibiotic cyclohexi-

mide interferes with glutamine synthesis in fungal cells. The fungicide dodine (n-dodecylguanidine acetate) damages the cytoplasmic membrane of fungal cells and in some cases it interferes with anionic sites at the cell surface.

(Project J-91)

Test Control of Plant Diseases by Soil Treatment

Laboratory and greenhouse tests indicate that a number of chemicals will control several soil-borne pathogenic fungi. A few materials have a wider range of activity than others. Two of the chemicals are excellent herbicides and nematocides as well as fungicides. Most of the chemicals tested have very little effect on soil bacteria at concentrations that will control pathogenic

soil fungi. Of the six best soil treatment chemicals found over past four years, only one is non-phytotoxic. One chemical out of the six best soil treatments found can be used on foliage. In general, most foliage fungicides make poor soil treatment chemicals while most good soil treatment chemicals are usually phytotoxic to foliage.

(Project J-93)

Improved Strains of Maryland Tobacco Resist Diseases

Resistance studies on the black shank resistant Mor 59 and 609A varieties of tobacco indicate that they are stable. Quality is high but yield per acre is consistently below the better Maryland varieties except in the presence of the disease. The two black shank resistant

varieties have been screened for resistance to Fusarium wilt and Black root rot. Mor 59 and 609A apparently have a high resistance to Black root rot. The three diseases mentioned are widespread in the Maryland tobacco-growing counties.

(Project J-95)

Plant-Parasitic Nematode Studies Continue

Work has continued on nematicides with more versatile characteristics than those in general use today. An organic phosphorus compound gave excellent nematode control on tobacco, had low phytotoxicity, was systemic in the plant and also on insecticidal killing aphids feeding upon leaves of plants growing in treated soil and had long-lasting residual nematocidal activity in the soil. A granular formulation of 1,2-dibromo-3-chloropropane was compatible when mixed with fertilizer and had the advantage that both materials could be applied to the soil in one operation. Excellent control of root-knot nematodes was obtained on cantaloupes and

tomato. At the rates used there was no phytotoxicity when the mixture was applied to soil at the time of planting the cantaloupe seed or when applied as a sidedress to tomato one week after transplanting to the field.

The relation of plant-parasitic nematodes to ornamentals in nurseries and established plantings is being investigated. At present the role of nematodes in the decline of certain ornamentals, such as established boxwood plantings, is obscure, and an interaction of nematodes with other plant disease organisms may be involved in some cases.

(Project J-96)

Study Physiology of Nematodes and Parasitized Plants

After removal from plants, respiration of plant-parasitic nematodes decreased gradually until death occurred. The rate of respiration was higher in nematodes in air with normal carbon dioxide content than in air with a higher content or lacking in carbon

dioxide.

A glycoside isolated from asparagus and toxic to nematodes was found to inhibit the cholinesterase enzyme system in the nervous system of nematodes.

An attempt was made to determine what chemical(s) caused the galling re-

action in tomato roots to infection by the root-knot nematode *Meloidogyne incognita acrita*. No differences in amounts of plant growth regulators were detected in healthy versus galled

roots, and the nematodes themselves appeared to lack plant growth regulators. The mechanism of gall formation remains obscure. (Project J-97)

Tobacco Mosaic Cuts Yield, Lowers Quality

Experiments show that tobacco plants infected at various times during the growing season with tobacco mosaic virus not only yielded less total tobacco but the tobacco was of lower quality

than that from healthy plants.

The grades showing the heaviest losses were Dull bright, Bright, Dulls, Seconds and Tips, respectively.

(Project J-98)

Field Test Results Encouraging in Boxwood Decline Study

The survey of the boxwood decline disease in Maryland was continued the past year in an effort to isolate any parasite or parasites that might be involved. Parasitic nematodes were present in the majority of soil samples tested. Nematodes identified are: *Gottboldsteineria buxophilus*, *Trichodorus primativus*, *Xiphinema americanum*, *Pratylenchus* sp., *Tylenchorhynchus* sp., *Ditylenchus* sp., *Paratylenchus* sp., *Aphelenchoides* sp., and *Hemicyclophorus* sp. The only fungus isolated to date is a species of *Fusarium*.

Greenhouse tests were devised to test the pathogenicity of the isolated *Fusarium* species in respect to drainage conditions. The test plants were divided into two groups; one group with proper drainage and one group with poor drainage. Each of these two groups was again divided into two groups, one group inoculated with *Fusarium*, the other group not inoculated.

The results indicated that the *Fusarium* is not pathogenic, but the decline symptoms were present on those plants subjected to poor drainage conditions. These findings bear out the results of the 1958 drainage experiment. This test will be repeated using a different inoculation technique.

Field tests were continued in three established plantings in the state. Two

plantings are in Queen Anne's County and the other one is in Harford County. These field tests are being carried out for the purpose of finding methods of controlling or at least slowing the decline of boxwood in Maryland.

The results of these field tests are encouraging. One of the plantings in Queen Anne's County has been divided into four plots and treated as follows: (1) 5-10-10 fertilizer only, (2) Nemagon (1, 2 - dibromo-3 - chloropropane) 10% granular, (3) A 5-10-10 fertilizer-Nemagon (10% granular) mix, and (4) Control.

The new growth was measured and the plants were rated on the basis of percent foliage affected.

The results are given in the Table at the top of page 37.

Similar results were present in the Harford County planting where a 67% liquid Nemagon was used. There were no check plants in this test.

Predisposition of the host appears to be important in this disease. Plants that were deeply planted, particularly in heavy soils, exposed without winter protection, heavily mulched, or planted in full sun were found to be more susceptible to decline. Latex (Wilt Pruf) gave good winter protection as does good screening.

(Project J-99)

The effect of nemagon—fertilization treatments of boxwood.
Prospect Plantation, Queen Anne's Co. 1959

Treatment	Index reading*	Aver. new growth**
Nemagon, 10% granular	2	3.01 cm.
5-10-10 fertilizer	1	4.06
Nemagon, 10% granular		
5-10-10 fertilizer mix	0	4.42
Check	3	2.17

*Rated on basis of foliage affected: 0 = none affected, 1 = 1-25% affected, 2 = 26-50% affected, 3 = 51-75% affected, 4 = 75-100% affected.

**10 measurements per plant, 10 plants per treatment measured.

Mercury Compounds Control Scurf in Sweet Potatoes

Numerous sweet potato varieties were tested for susceptibility to scurf in field plots. Sprouts were inoculated with scurf pathogen prior to planting in the field. None of the plant material tested had any high degree of resistance to this disease although there were differences in susceptibility.

Eleven foreign introduction sweet potatoes were inoculated with the black rot pathogen in the laboratory. Unfortunately, none appeared to possess any

high degree of resistance to this disease.

The organic mercury compounds continue to be outstanding in the control of scurf of sweet potatoes. Treatments were applied as dips of scurf-infected sprouts prior to planting in plots. Results indicated that the mercury compounds, Puratized Agricultural Spray and Tag, at the concentration of 1-1000 gave excellent control of scurf, and there was no evidence of phytotoxicity.

(Project J-100)

Temperature Affects Role of Boron in Sugar Translocation

The movement of hormones such as 2,4-dichlorophenoxyacetic acid (2,4-D) from leaves to other parts of the plant has been shown, by others, to depend on the movement of sugar. Research at this Station first demonstrated that boron is required for the translocation of sugar and that, because of the effect of boron on sugar translocation, boron can affect the movement of plant hormones or growth regulators. The effect of boron on sugar translocation is thus studied indirectly by this approach. Us-

ing this approach to study the effect of boron on the translocation of sugar in bean plants, it was found that there was no "boron effect" at 70° F., that the maximum "boron effect" occurred at 80° F., and that at 85-90° F., there was no effect of boron on sugar movement. These findings highlight the importance of considering temperature—at least when the hypothesized role of boron in sugar movement is being evaluated.

(Project K-8-c)

DAIRY

Research efforts in dairying involve work on the metabolic processes of the cow to provide information making possible more efficient milk production, the evaluation of forages and other feeds for milk production, study of the mechanism of several metabolic diseases, establishment of new information on the chemistry involved in milk flavors and the development of processing techniques resulting in dairy products most desired by consumers.

Milk Composition Altered by Feeding Pelleted Ration

The composition of milks produced by cows fed combinations of pelleted hay, flaked corn and ground corn was markedly different from that produced by the same animals receiving long hay. Milk fat content decreased as much as 70% and the protein and SNF (solids-not-fat) increased 20%. Chemical changes in the milk fat were also observed. The concentration of unsaturated fatty acids, considered to be essential to good nutrition, was increased significantly.

Milk production was not greatly affected by these rations. The pelleted hay appeared to be less palatable than long hay, and in some cases feed intake could not be maintained, resulting in

decreased milk production. However, the better producing animals in this experiment maintained their production on pelleted hay during periods of up to 10 weeks. The net decrease in total milk solids did not appear to be compensated by an increase in milk production.

The production of milk with low fat content under present marketing conditions would be unsound economically. However, the chemical composition of this milk is in harmony with current theories related to proper nutrition. It is conceivable that special markets exist or may be developed for a milk with less fat, more protein and richer in essential fatty acids. (Project G-51)

Study Pelleted Hay for Dairy Heifers

Feeding trials were conducted to study the effect of pelleting hay on the growth rate of dairy heifers. In a 103-day trial, heifers which were fed pelleted timothy hay consumed 1,335 pounds of hay and gained 234 pounds. The heifers which were fed long hay consumed 1,130 pounds and gained 165 pounds. Both groups received 3 pounds of grain per day.

In a 113-day trial with third cutting alfalfa hay cut at two stages of maturity, the effect of pelleting was similar. Heifers receiving pelleted alfalfa consumed 1,704 pounds and gained 218 pounds while the heifers receiving the long alfalfa consumed 1,355 pounds

and gained 148 pounds. The differences due to stage of maturity were not significant.

Rumen samples were collected from those heifers which were fed the alfalfa hay. The animals fed the pelleted hay had a total volatile fatty acid concentration of 119.8 milliequivalents per 100 milliliters and those fed the long hay had a concentration of 88.3 milliequivalents per 100 milliliters. Heifers fed pelleted alfalfa had an acetic acid concentration of 81.3 milliequivalents per 100 milliliters of rumen fluid and the rumen fluid from the heifers fed long alfalfa hay had a concentration of 56.2 milliequivalents.

While the increased growth and efficiency of feed conversion favors pelleted hays, the present high cost of grinding and pelleting forages must be

reduced before this method of handling hay gains wide acceptance.

(*Projects G-47, G-51*)

Compare Silage Effects on Milk Production

Hay-crop silages fed as the only source of forage are sometimes not consumed at rates sufficient to promote high milk production. In a feeding trial which compared alfalfa hay, alfalfa hay plus lactic acid, and alfalfa silage, neither the consumption rate of dry matter nor milk production were significantly different. This indicates that this alfalfa silage did not contain the factors which sometimes decrease dry matter consumption rate.

In another trial, a male sterile corn silage was compared with a normal corn silage for milk production. The consumption rate of dry matter and the milk production were slightly lower for cows on the male sterile corn silage. However, the results indicate that feeding values of the two silages were about equal. If high yields per acre could be obtained from the male sterile corn, it could be used as a source of silage.

(*Project G-52*)

Study Effect of Orchardgrass Fertilization for Dairy Pasture

Pasture studies comparing an orchardgrass-ladine mixture with orchardgrass (fertilized with 100, 200, and 300 pounds of nitrogen per acre) were initiated in cooperation with the Agronomy Department. Only a part of a season's grazing was completed during 1959, and the results do not show any major differences at this time. Meas-

urements of milk production, carrying capacity and yields of nutrients per acre were obtained.

The establishment of a Midland Bermudagrass with sod seeding of cereal rye was carried out to compare the possible value of Bermudagrass as pasture for dairy cattle.

(*Project BG-1*)

Evaluate Nutritive Value of Forages

Two first cuttings of Williamsburg and Dupuit alfalfa were made and the digestibility of each forage sample was determined by feeding to steers. The preliminary results indicate that Dupuit has 2 percent lower digestibility of

dry matter than Williamsburg alfalfa harvested on the same date. These results are only preliminary, and further cuttings will be made to determine if these differences are significant.

(*Project G-47*)

Seek to Perfect Omasal-Abomasal Shunt Operation

Work was started to develop a functional omasal—abomasal shunt in goats. When the operation is perfected, the animals will be used to determine

the extent and character of digestion in the forestomach of the ruminant.

(*Project G-39*)

Volatile Fatty Acids Absorbed from the Forestomach of Ruminants

Analysis of samples of rumen and abomasal ingesta showed that there was a 15-to 20-fold decrease in total

VFA concentration from the rumen to the abomasum. The proportion of butyric acid in the abomesal ingesta was

markedly lower, which suggest that butyric acid was being selectively absorbed from the forestomach. This is contrary to the recent scientific literature on this subject. However, it may be that the acetic and propionic acid

producing bacteria continue to function for a period in the abomasum, thus raising the per cent of these two acids in this organ.

(Project G-39)

Udder Edema Related to Blood Constituents

Blood samples drawn at parturition have been analyzed for serum protein, freezing point and conductivity. There appears to be some correlation between each of these measurements and the severity of udder edema. Constituents

other than protein, however, appear to be responsible for some of the changes in the osmotic pressure of the blood at calving time.

(Project G-37)

Investigate Metabolic Diseases of Dairy Cattle

Studies have been carried out to gain an insight into the causes and means of prevention of the metabolic disease, ketosis. Radio-isotope techniques using acetic acid 1- C¹⁴ have been employed to determine the rate of acetate metabolism in steers and

dry cows. Determination of this rate in normal and ketotic animals will show the metabolic effects of ketosis. Similar techniques for the study of glucose metabolism are being developed.

(Project G-37)

New Study Methods Used in Glucose Metabolism Research

A closed artificial heart-lung perfusion system is being used to study the liver formation of glucose from various radioactive carbon labeled compounds. A radioactive isotope dilution technique is being developed to determine the metabolic rate of glucose oxidation. A continuous flow ion-chamber electro-

meter system has been developed for the study of the oxidative metabolism of glucose. Reports by Kleiber have been confirmed and extended. The process of milk ejection (letdown) has been found to stimulate glucose oxidation.

(Project G-38)

Turnover Time and Metabolic Pool Size for Acetate Established

Using radio-isotope dilution techniques, the turnover half-time for acetate in steers was found to be 1.6 to 4.0 minutes. Metabolic pool size varied from 300 to 650 milligrams of acetate per cwt. A metabolic rate of about 5 grams acetate per hour per cwt. was observed. Similar values for half-time and pool size were observed for a lacta-

ting cow, but the metabolic rate was found to be 3.9 grams of acetate per hour per cwt.

Injected growth hormone appeared to increase the metabolic rate for acetate. Fasting apparently increases the oxidative utilization of palmitate and decreases the oxidative utilization of acetate.

(Project G-46)

Radioactive Tracers Aid Study of Mammary Gland Growth

Results with radioactive phosphorus as a tracer, to determine the total size and rate of growth of the mammary

gland, indicate that this is a satisfactory technique. Studies are now in progress on living animals to establish

these measurements.

Additional work involves establishing the tissue and cellular distribution of C^{14} labeled progesterone in relation to

mammary gland growth, the initiation of lactation and the excretion of 17-ketosteroids.

(Project G-50)

Optical Methods Used to Study the Physical State of Fat in Ice Cream

The development and use of optical methods provided basic information on the state of butterfat in frozen dairy products. Results of the optical studies show that the fat particle size in ice cream mix increases during the freezing procedure. The degree of fat dis-

persion in ice cream and related products is important to understanding and controlling certain body and texture characteristics important in the production of high quality products.

(Project G-42)

New Methods of Analysis Developed for Carbonyl Compounds

In anticipation of the probable contribution of carbonyl compounds to the characteristic flavors of concentrated milks, work has continued on improvements in the methods of analysis for these compounds.

Methods have been developed for the direct conversion of trace quantities of carbonyl compounds in concentrated and fluid milks to colored 2, 4-dinitrophenylhydrazones which can then be extracted from the milk in a stable form for study and analysis. The extracted hydrazones are isolated from the co-extracted fat by chromatography on magnesia columns. These same col-

umns can be used for separation of the hydrazones into various derivative classes, such as saturated aldehydes, unsaturated aldehydes and ketones. Each class is then separated into individual compounds by liquid-liquid chromatography utilizing acetonitrile and hexane as the two liquids. The isolated compounds can then be quantitatively determined by colorimetric measurements.

This systematic scheme provides objective methods to complement organoleptic observations in the study of process and storage variables as they affect the flavor of concentrated milks.

(Project G-48)

Study Sulfur Distribution in Heated Milk

Reports from other laboratories have suggested that sulfur compounds become chemically bound to butterfat during high temperature heating of milk, resulting in characteristic off-flavors associated with the fat phase. Study of the distribution of radioactive sulfur in the milk of a goat fed S^{35} has been conducted during the past year.

Using this sensitive technique, it was

observed that there is no significant increase in radioactivity of fat from heated milk as compared to fat from raw milk. It is believed that previous indications of the occurrence of sulfur compounds in the fat from heated milk may have been due to non-fat compounds, extracted from the milk with the solvents used to separate fat.

(Project G-40)

Colorimetric Fat Test Applied to Ice Cream

The colorimetric method of determining the fat content of milk by the hydroxamic acid reaction has been mod-

ified for the determination of fat in ice cream. The interfering color from the degradation of sugar during the

conversion of butterfat to hydroxamic acids has been eliminated by partitioning the reaction products between water and ether. The interfering sugar products are soluble in water, and the fat products are soluble in ether.

This work is part of a program de-

signed to develop direct colorimetric methods of fat analysis in dairy products which may be more adaptable to modern instrumentation and automation than the older methods involving physical isolation of the fat.

(Project G-35)

Radio-Isotopes Used to Study Flavor Defects in Milk

Copper in milk is known to promote oxidized flavor in raw milk supplies and manufactured products. Experiments employing radioactive copper administered to individual cows have yielded much information concerning the entry, distribution and chemical state of copper in the milk. Results indicate that the ration of copper associated with the fat phase of milk is directly related to the incidence of oxidized flavor. During early lactation this ratio changes markedly, making the milk more susceptible to the flavor defect. Methods are being developed to

characterize cows producing milk subject to oxidation by studying the physical and chemical properties of milk fat globules.

Additional information concerning the chemical pathways of oxidized flavor has been obtained through the use of radioactive ascorbic acid and substances capable of chelating or tying-up the copper in milk.

A more complete understanding of the basic chemical mechanism responsible for oxidized flavor should make possible its ultimate elimination from the milk supply.

(Project G-34)

Fruit Concentrates and Essences Improve Ice Cream Flavor

Results have been obtained on the use of peach, blueberry, grape, apple, cherry, red raspberry and strawberry flavor concentrates in ice cream, sherbets, and ices. The consumer acceptance of these products has been very good especially for the apple, blueberry and peach products when compared with products made without the use of concentrated juice or essence. Results indicate that concentrated fruit juices or essences may also be used advantageously in the manufacture of ice milk and variegated ice cream.

(Project G-42)

Checking the quality of ice cream mixtures flavored with fruit essences and concentrates.



ENTOMOLOGY

The Department of Entomology endeavors to perfect measures for the control of insect pests so that quality of products will be improved, production costs will be reduced and a greater margin of profit will be possible. In addition to research of a practical nature, Entomology staff members are concerned with many fundamental problems in the fields of insect classification, biology, physiology and toxicology.

Polyhedrosis Virus Important in Cabbage Looper Control

In recent years the cabbage looper has become an important pest of peppers, tomatoes, kale, spinach and other cole crops. Insecticidal control has been extremely difficult, particularly on the leafy crops and broccoli, since complete spray coverage of such crops is hard to obtain and because residue restrictions prevent the use of some of the more effective insecticides near harvest time. For the past three years, the polyhedrosis virus which causes a wilt disease of cabbage loopers has been observed late in the season in broccoli fields throughout the Eastern Shore section of Maryland. Though the disease has not occurred until late in the season after heavy looper populations have severely injured growing plants, it has

been an important factor in the production of clean heads at harvest time. The virus appears to be specific for cabbage looper, and no other species of insects attacking cole crops is affected. The organism is extremely virulent, and once the disease becomes prevalent in the field, entire looper populations are almost completely destroyed within a period of a few days. Preliminary attempts in Maryland to produce the virus in the laboratory, in amounts necessary for artificially infecting loopers in the field, have not as yet been successful. Sufficiently encouraging results were obtained to expand the research program on this problem next year.

(Project H-46-e)

Phosphamidon and Cygon Promising New Insecticides

Over the past 15 years the Department of Entomology has tested and observed many insecticidal chemicals used against insect pests of most vegetable crops for the purpose of finding chemicals that are safe to handle, highly effective against the insect pests involved, that do not leave harmful residues, and do not affect the vigor or quality of the crop. As a group, phosphorous systemic insecticides, particularly the short-lived systemics, appear to have great promise for the future. Extensive work has been underway on two of these materials, phosphamidon and cygon. Phos-

hamidon has considerable promise since it is highly effective against the European corn borer and against aphids, particularly the green peach aphid, a species resistant to many insecticides. It has the added advantage of being relatively short-lived, the residue usually disappearing in 6 to 8 days. Work is being done in cooperation with the California Spray Chemical Corporation to obtain information for the approval of this insecticide by federal regulatory agencies.

Cygon is a relatively safe material to apply and is effective against a large

number of insect species. Considerable information has been obtained on field performance. These two materials have been used primarily in foliage sprays. Work has also been done with the longer-lived systemics, Di-syston and phorate, applied in the soil at planting

time. Results have been encouraging, but these insecticides will probably be limited to a few specific uses. There are several new systemics now becoming available that shall be evaluated in the near future. (Project H-46-e)

Two Insecticides Available for Corn Earworm Control on Beans

In 1959 experiments, both DDT and Sevin were highly effective in controlling the corn earworm on both green and lima beans. A single application of either Sevin or DDT reduced the infestation on green bean pods from 40 percent to less than one percent. Sevin is preferable to DDT for earworm control on green beans because residues are less hazardous and less persistent. Yields of Fordhook lima beans treated with Sevin or DDT were increased five times over those from untreated plots. Where lima bean plants are not used for animal food, DDT is preferred for earworm control because treatments with Sevin are more expensive. If lima bean plants are used for forage, Sevin should be used. Sevin also has the advantage over DDT in being effective against the Mexican bean beetle.

On snap beans Sevin at the rate of

1½ pounds per acre should be applied when the blossoms begin to drop and when first bean pods are in the pin stage. On late beans a second application should follow the first picking.

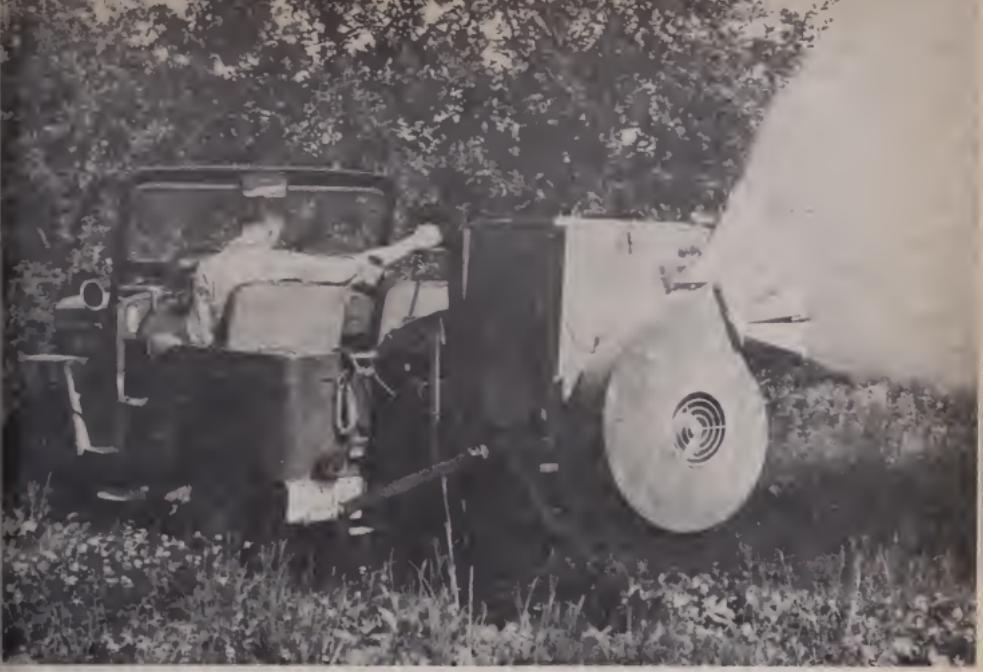
The number of applications of DDT or Sevin on lima beans at the same rate, 1½ pounds per acre, will vary with time of maturity. First treatments should be made about August 20 and repeated every 10 days until harvest. Treatment dates on the southern Eastern Shore should begin a week earlier. Growers should not wait until earworm injury is evident, for by this time considerable damage has already been done. It is an unusual season in which earworm does not attack late green and lima beans. (Project H-46-e)

Spray Program Improved for Control of Apple Insects

Many different new and old insecticides, acaracides and fungicides were used in experiments during 1959. The experiments consisted of 42 plots, 31 of which were in an orchard of 35-year-old Stayman winesap trees, and 10 plots in a 35-year-old orchard of Golden Delicious apples. In general, the combination of materials used in each plot was designed to control all major pests of apples. Some of the combinations tested gave good performance and were recommended in the 1960 Spray Calendar.

Codling Moth—The standard recommended program of Ryania, lead arsenate and parathion gave excellent re-

sults in all orchards where it was used. Of the newer materials tested, Guthion gave outstanding results for the control of codling moth and performed satisfactorily against red-banded leaf roller and orchard mites. It appeared to be safe from the standpoint of phytotoxicity. Another one of the newer insecticides, Sevin, was used in late season sprays and also gave excellent control of codling moth. The objectionable feature of this material is that orchard mites tend to build up where it is used. It is not recommended in Maryland orchards before the third cover spray because of its tendency to produce rus-



Almost 60 different dust formations for apple and peach insect control were tested in 1960.

setting on fruit. Many other combinations showed promise of controlling some of the major pests, but further experiments will be needed before they can be recommended.

Orchard Mites and Rosy Aphids—Experiments using oil emulsion in combination with some of the phosphates applied in the delayed dormant stage have given outstanding results on the control of orchard mites and rosy aphids. A combination of these two materials was recommended and used in many commercial orchards during 1960, and in all cases, the performance was outstanding. There will be a much greater demand for this combination spray in 1961.

Apple Maggot—Probably the outstanding performance of any material was the results obtained with Sevin on the control of apple maggot. Three applications of this material used at 2

pounds per 100 gallons of spray applied 30, 20 and 10 days before harvest gave what appeared to be 100 percent control in an orchard that had been heavily infested for the past three years. These same treatments also gave excellent control of codling moth and red-banded leaf roller.

1960 Experiments—Experiments in 1960 consisted entirely of testing dust formulations on both apples and peaches. Approximately 60 formulations were used in this series of experiments. The data on these experiments have not been completed, but there are indications that many of the formulations have given good control of rosy apple aphids and codling moth. However, no satisfactory formulation has given control of orchard mites. Further experiments will have to be conducted before any recommendations can be made.

(Projects H-48 and H-69)

Research Successful on Corn Borer Control in Peppers

During the past several years the European corn borer has caused great damage to peppers in the Del-Mar-Va area. At the request of pepper processors in 1959 the Departments of Entomology at the Universities of Maryland and Delaware and the Virginia Truck Experiment Station cooperated in an "all-out" research program on this problem. Screening work on new insecticides was done at the Virginia Truck Experiment Station, extensive field experiments with approved insecticides

were carried out in Delaware and work on insecticidal residues of effective and promising insecticides was done in the residue laboratory of the Department of Entomology, University of Maryland. The results of the effort were extremely gratifying. Better control recommendations with available insecticides for 1960 were possible, and information for approval of more effective newer insecticides for 1961 was obtained.

(Project H-67)

Research on Alfalfa Weevil Continues

With the recent action by the United States Food and Drug Administration, our most effective weapon against alfalfa weevil has been removed from our arsenal. Heptachlor had given very satisfactory control of the weevil for a number of years, but residues remaining on the hay at harvest preclude its use. Current studies are underway to determine decisively if there is any feasible method of utilizing heptachlor under Maryland conditions.

In addition to this work, results have been obtained which indicate that a number of insecticides will be available to forage producers. These newer materials, although not quite so effective

as heptachlor, show promise of providing the grower with a number of materials to choose from. Among these newer compounds are dimethoate (which also gives excellent control of pea aphids), Guthion, Thiodan and Trithion. These last three also give effective control of pea aphids, and Guthion is also an outstanding spittlebug insecticide. Residue studies and experiments with contamination of milk are currently being undertaken by the manufacturers of these materials in anticipation of registering these compounds for use on forage crops.

(Project H-71)

Further Investigate Mosquito Biology and Behavior

Mosquitoes are of great economic importance to Maryland residents. Studies are being carried on to obtain more knowledge of the relationship of mosquitoes to eastern equine encephalitis. This work has been done with the cooperation of the Department of Veterinary Science and the U. S. Department of the Army. Evidence has been obtained that the two common salt marsh mosquitoes and two of the common floodwater species are potentially important vectors of EEE, a virus disease which affects birds, horses and man.

Small biting midges (genus *Culicoides*) which are close relatives of mosquitoes have been comprehensively studied. Abundant evidence was obtained to show that two species of these midges are unable to transmit the EEE virus from viremic chicks to normal chicks under laboratory conditions. Yellow fever mosquitoes, used as controls, did transmit the virus under the same conditions. The virus persisted in *Culicoides* for seven days. Mechanical transmission of EEE virus by *Culicoides* occurred when midges were interrupted

while feeding on viremic chicks and immediately placed on normal chicks. It was concluded that biting midges are not important in the epidemiology of EEE in Maryland.

With the cooperation and financial support of the Fish and Wildlife Service, U. S. Department of Interior, and with the assistance of Maryland State Board of Agriculture personnel, careful observations of salt marshes in Worcester and Somerset Counties have been made during a two-year period. These studies showed that in a marsh properly ditched for mosquito control wildlife

populations were not affected adversely. In a marsh where water control structures had been built to keep the marsh flooded during the winter for the benefit of waterfowl, it was found that careful manipulation of the structures would be necessary to allow the removal of sheet water in the summer. It is the sheet water which is inaccessible to fish that is undesirable from the mosquito control standpoint. Research will be continued to make mosquito control work more effective without endangering wildlife. (Project H-73)

Insect Nutrition Affects Insecticide Resistance

Recent studies on *Drosophila* flies have indicated that nutrition has considerable effect on susceptibility to insecticides. Studies of flies reared from egg to adult on diets varying only in their nitrogen content indicate that increasing dietary nitrogen results in increasing susceptibility of the adult flies to DDT. The change is marked also by many changes in the normal amino acid content of the mature larval stage.

Some amino acids increase in quantity, others decrease and still others remain unchanged. The behavior of the amino acid alanine is particularly interesting, since it decreases quantitatively as dietary nitrogen increases. This is analogous to increases in DDT in resistant insects reported by workers elsewhere. Current studies are underway to try to determine the exact role of alanine in DDT resistance. (Project H-78)

HOME ECONOMICS

The variable quantity and kind of protein eaten daily has been an indicator of health throughout the world. Since protein is not stored in the body like carbohydrate and fat, nitrogen balance (the difference between nitrogen intake and nitrogen output) has been used as a criterion of protein adequacy. Normally, nitrogen is excreted as a result of body metabolism. If extra protein is eaten, more nitrogen is excreted or if little protein is eaten the quantity of excreted nitrogen from normal metabolic processes may be sufficiently large in quantity to cause negative nitrogen balance.

Protein Intake and Nitrogen Balance Studied

Studies of self-selected diets of college women have shown that a number of students eat less protein daily than the 65-75 gm that is recommended by the National Research Council. The range of protein intake of 171 women students on such diets at North Texas State College was found to be 19-113 gm daily with an average of 52 gm protein.

The controlled dietary experiments of the nutrition laboratory have been studies of the nitrogen balance response to the following: 1) constant relatively low protein intakes, 35 gm (Exp. V) and 42 gm (Exp. I); 2) gradual

changes of protein intake from 12 to 50 gm daily (Exp. II, III); 3) abrupt changes of protein intake from 12 to 35 gm per day followed by 12 gm per day (Exp. IV).

Forty different college women consumed the low protein diet of 12 gm daily for 12-15 days at some time during one or another of these experiments. This diet was expected to create negative nitrogen balance since it was inadequate in most of the essential amino acids and contained less than half the minimum quantity of total protein that is believed by most authorities to be the minimum daily need for college women, specifically 31-35 gm. The plan was to deplete the slight protein store of each subject, bringing each to a constant minimum nitrogen excretion and to a common basis, uninfluenced by previous diet, for beginning experimentation. Approximately one-third of the subjects of these experiments, surprisingly, were in positive nitrogen balance during this low intake period: 3 after 6 days on the diet; 15 after 9 days; 13 after 12 days; and 14 after 15 days. The majority of the subjects were approaching nitrogen equilibrium. This agrees with the literature of self-selected diets showing positive and negative nitrogen balances on

Caloric intake was adjusted for each subject of the protein utilization study to hold fluctuations in body weight to a minimum. Here the caloric content of the diet is being determined.



low protein intakes of different persons and confirms by controlled experimentation the fact that it is possible to be in positive nitrogen balance on inadequate quantity and quality of dietary protein. This raised the question of nitrogen balance being a valid criterion for adequate protein in the daily diet. The protein of this diet was only 65-68% digestible.

The diet used in four of these experiments for the higher levels of dietary protein was the low protein diet of 12 gm supplemented with beef or haddock to increase the protein of the diet to the desired level. This supplement was eaten at the evening meal. The diet was adequate in essential amino acids when the total protein content was more than 25 grams. As the increased amounts of beef and haddock were eaten, the subjects eating haddock had more essential amino acids than the others. It is interesting that these subjects having more quality protein (essential amino acids) did not show greater nitrogen balance than the other subjects. The protein of these diets was 86-91% digestible.

Daily caloric intake was adjusted for each individual to prevent an increase or decrease of body weight. The body weight of the subjects was controlled and showed an average difference between low and high weights of 7.5, 5.6,

4.0, 3.9 pounds for the consecutive experiments lasting 6-8 weeks. The average caloric intake centered about 3000 Calories. An experiment was designed to check this higher than usual caloric need using an iso-caloric diet of 3000 Calories per day. The average body weight fluctuation during this experiment was 5.2 pounds, but three subjects gained 6-8 pounds, and the other subjects fluctuated from 3-5 pounds as the subjects in previous experiments.

In some of these metabolic studies the fat intake was low, some moderate and others high. This amounted to fat equivalent to 24, 30-36 and 48% of the total daily Calories.

Nitrogen balances of 62 college women eating various low protein diets were similar for individuals eating the same amount of protein daily regardless of caloric intake, fat intake and gradual or abrupt increase of dietary protein.

In experiments where a constant intake of protein was eaten for 42-54 days or protein intake was not abruptly changed, a rhythm of nitrogen balance was shown with a peak of retention between 33 and 39 days (43 individuals). The differences in nitrogen balance in these experiments were statistically significant at either the 5 or 1% level.

(Project Y-1)

Measure Air Permeability of Clothing

The regional textile project NE-19 is continuing to study consumer satisfaction with garments as related to characteristics of the garment and consumer practices in selection, use and care. Our Department of Textiles and Clothing, College of Home Economics, has a supporting project on measurement of air permeability on selected garment fabrics before and with use.

Measurements of air permeability

were taken at selected areas on 18 men's new shirts and women's slips from the cooperating stations. After a designated number of wear and care periods, the measurements will be taken again. These data are expected to contribute to understanding of the relationship of air permeability to comfort and other qualities of the garments after periods of wear.

(Project Y-2)

HORTICULTURE

The efforts of Horticultural research are aimed at more efficient production of better fruits, vegetables, flowers, and ornamental plants, with the common goal of higher returns for the producer and better products for the consumer. The research program thus involves studies ranging from plant breeding to the canning and freezing of fruits and vegetables, carried on in the laboratories and greenhouses at the University, on the experimental farms, and on the farms and orchards of cooperating growers throughout the state.

Some of the recent results of the research program are briefly presented in the following pages. More detailed information is available in scientific journal papers, station bulletins, and popular articles released by the Experimental Station.

Promising Vegetable Varieties Studied

A continuous and exhaustive study of new and improved varieties of vegetable crops is maintained to provide detailed information on variety capabilities. All characters pertinent to growing, harvesting and raw product preparation are evaluated objectively.

New varieties found to have characteristics of importance are: Golden Sensation, a sweet corn variety in which pericarp development is slow; A-45, a canning pea variety (wrinkled seed) which is as early as Alaska and produces satisfactory yields; GB-13, a white seeded Tendercrop type snap bean developed at the Geneva, N. Y. Experiment Station, which has high yielding ability under Maryland conditions. Like

Tendercrop, seed and fiber development is slow. (Project Q-74)



GB-13 a new, high-yielding, white-seeded Tendercrop-type snap bean.

Question Texture-Pectic Substance Relationship in Apples

Pectic substances are thought to exert an important influence on the textural properties of raw and processed apples. Texture is considered to include the factors of firmness and wholeness. The classical concept concerning the role of pectic substances in apples is the greater amount of pectin, particularly the acid soluble fraction, the firmer

the fruit. Recent results have shown that this is not entirely correct, since varieties that are soft or those which are firm may have about the same amount of pectic constituents. Further, all varieties do not show a high degree of correlation between amounts of pectic substances and firmness or wholeness of the raw or sliced apple. From

the gathering evidence, it thus appears that other factors of the alcohol insoluble solids (AIS) such as starches, hemicelluloses and celluloses may also

be playing an important role in the textural aspects of apple products.

(Project Q-58-p)

Variety, Maturity and Storage Influence Apple Slice Quality

Processors of canned apple slices must maintain a strict control over their raw stock to manufacture a top-notch product. This study has shown that proper variety is a most important factor. Of the varieties studied, York Imperial, Golden Delicious and Jonathan showed the desirable characteristics of proper firmness and wholeness, and a bright golden color. Other varieties such as Stayman, Rome Beauty and Northwest Greening were generally soft and exhibited a dull color, even when carefully handled.

Time of harvest or average maturity of the raw apple had an important effect on the processed slices. In general, apples of the more advanced harvests gave slices of the highest quality. This was especially true for the factors of color and flavor, and if the apples were not stored before processing.

If the apples were held in storage prior to processing, several factors were important. First apples harvested in the early season should be ripened in storage to give the best color, flavor and reduce the chance of a tough and rubbery product. Second, apples harvested in the mid or late seasons should not be held long before processing because they decline very quickly in quality. They would be lacking in firmness and dull in color. In determining the quality attributes of canned slices, it was



Newly-developed experimental Pyrex glass cooker, used to control both time and temperature factors in apple processing studies. Slices may be easily observed at each stage of the cooking. Steamed slices are shown at the discharge end of the cooker.

found that texture (45%) and color (45%) were the most important factors influencing the overall grade. Flavor of the canned slices had very little influence on grade. Judges felt as long as the flavor was normal, no other requirement was needed. Consumers of canned apple slices will add sugar, spices and lemon juice to their pies, thus modifying somewhat the initial flavor of the processed product. Results indicate that most quality emphasis in the manufacture of canned slices should center in the texture and color areas.

(Project Q-58-p)

Quick Test Found for Vegetable Maturity

A new quick test which determines the viscosity of slurries of macerated vegetable tissues and water has shown promise as a maturity index of several vegetable products. Spread or limit of

flow of these slurries is measured on an Adams Consistometer, which is a stainless steel plate with the surface divided into concentric rings $\frac{1}{4}$ of an inch apart. The amount or limit of flow is

directly proportional to the alcohol insoluble solids (AIS). The higher the AIS, the lower is the moisture content and, thus, the thicker the slurry under standard operating conditions.

In the cases of lima beans and peas, the technique measures almost directly the AIS of each individual and gives a close estimate of the average maturity of a lot. In raw sweet corn, the limit of flow measures AIS and, additionally, any effect pericarp may have on the

flow. For raw snap beans, the slurries are indicators for the succulence of the pod, amount of seed and fiber.

This technique is practical for many vegetable commodities as a maturity measure on the batch basis and will probably be fully exploited by the food industries when applied to almost continuous recording in-line maturity measuring procedures.

(Project Q-58-f)

Study Effects of Growth Regulators on Lima Beans

Indoleacetic acid (IAA), naphthaleneacetic acid (NAA) and naphthoxyacetic acid (NOA) have shown beneficial results on lima beans under certain climatic conditions. Studies with Fordhook 242 limas have shown that the auxin level of the plants just prior to opening of the flowers is apparently related to yield and concentration of set. The work, conducted over a period of three years, indicates that if the auxin level at this time is low, a spray treatment of IAA will enhance yield, and that this condition is found with hot, dry weather during the 4 weeks

after planting. If rainfall is abundant the auxin level of the plants will probably be high and a response may be obtained to NAA or NOA.

Applied at 100 gallons per acre, appropriate concentrations of the materials are probably in the range of 50-100 ppm IAA, 5-15 ppm NAA or 50-150 ppm NOA. Additional experimentation will be required before complete reproducibility of results can be assured. Work is continuing in an effort to make Fordhook limas a profitable crop for Maryland. (Project Q-77)

Pocomoke, New Tomato Variety, Released

Tomato processors recently requested the release of tomato breeding line 314-1-1-1-1, to fill a need in the industry. The line has been named Pocomoke (Po-ko-mok).

The new variety combines the characters of deep red color when fully ripe, a high degree of firmness, resistance to cracking, resistance to sunburn, a semi-dwarf habit of growth and tolerance to Fusarium wilt. Pocomoke fruit is somewhat small compared to present day varieties, averaging 4 to 6 ounces. Fruit size may be improved by selection and use of proper cultural practices.

Because of the firmness of the fruit and of the large percentage of fruit ready for harvest at one time, the variety is believed to be adapted to mechanical harvesting operations.

Observations indicate that concentration of set and fruit size are enhanced on light, sandy loams with fertilizer applications of less than 1000 pounds per acre. Plant population should be 6000 to 8000 plants per acre. Considerable additional testing will be required before complete cultural recommendations can be made.

(Project Q-82)



The proper storage period hastens flower development of azaleas in the greenhouse. Left: One month at a storage temperature of 42 degrees F. permitted faster development than either 50 or 35 degrees F. Right: The use of low intensity light during storage permitted faster development of flowers than dark storage of plants.

Urea Sprays May Have Place in Strawberry Culture

Work with foliar applications of urea at different rates and times and on several varieties of strawberries has shown that it can be used safely and economically under certain conditions. Spray applications varying from 5 pounds to 55 pounds of actual nitrogen per acre were made at various times. The spray was applied only on the foliage. Rates up to 20 pounds at full bloom were safe, whereas, the 35-pound rate caused some injury. The variety Tennessee Beauty was more susceptible than Dixieland. Injury caused by foliar applications of urea had no stunting effect on

strawberry plant growth. If the fertility level was low, a foliar application of urea before or during full bloom resulted in an increase in fruit yield. This was due to an increase in fruit numbers caused by the reduction of blasting of the weaker flowers.

Foliar application of urea can be an efficient method of supplying nitrogen to the plant during a period of dry weather. This may be especially critical during the flower initiation period in late summer when nitrogen assimilation is particularly important.

(Project L-79-a)

Holding Temperature Softens Processed Sweet Potatoes

Breakdown or softening of processed sweet potatoes has been frequently linked with the use of stored roots as the source of canning stock. However, both the grower and the processor commonly find it necessary to hold the canning stock for a few days to a week or more after harvest. Depending upon the harvest date, the roots are subject to a wide range of temperatures.

A study, conducted during two seasons with three different lots of Nema-gold sweet potatoes, has shown a marked effect of holding temperatures upon firmness of the canned product. Roots were held at temperatures ranging from 32 to 95 degrees F. for periods of one and two weeks prior to proc-

essing. A soft canned product was consistently associated with a holding temperature of 60 degrees F. of one week duration. Holding temperatures above or below 60° resulted in a firmer canned product, with maximum firmness attained at the extremes 32° and 95° F. Roots processed immediately after harvest gave a desirable firm product.

This adverse softening response, evident in the processed product following a 60 degrees F. post-harvest holding temperature, is a direct contrast to the excellent fresh quality maintained by sweet potatoes when stored at 60 degrees F. for several months. The processing of freshly dug sweet potatoes

would seem the most practical means of assuring a firm canned product in

view of these temperature effects.

(Project Q-79-g)

Test Benefits of Seed Firming of Snap Beans

The concept of seed firming was applied to commercial plantings of snap beans. The firming device used was a wheel 8 inches in diameter having a semi-pneumatic tire 1 inch in diameter. The wheel was mounted, designed and machined by Department of Agricultural Engineering on a Flexiplanter so that it rolled on the bottom of the seed furrow directly behind the double disk openers. The firming wheel was under down pressure of from 15 to 25 pounds as provided by spring tension. Each seed was firmed into the soil at the bottom of the seed furrow and then covered with loose soil.

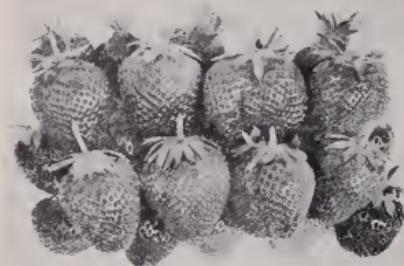
In a sandy loam soil, seedlings from firmed seed emerged with a high degree of uniformity and two days earlier than those from unfirmed seed. In tests conducted on a clay loam soil, uniformity and time of emergence were similar



Seed firming wheel mounted between disk openers and seeder drive-wheel.

for seedlings from firmed and unfirmed seed. However, at harvest time there was an increase in the number of plant bearing pods and also an increase in the number of pods per plant where seed firming was used. (Project Q-77)

Release Midway, New Strawberry Variety



Midway strawberry—a new joint introduction from the USDA-Maryland Experiment Station breeding project.

A new strawberry named Midway was released as a joint introduction from the U. S. Department of Agriculture and the University of Maryland Experiment Station cooperative berry

breeding program.

Midway (tested as Md-US 2389) originated from a cross of Dixieland X Temple and was first selected in 1953 at the Maryland Research Farm, Salisbury. It is a mid-season variety, resistant to the common race of the red stele disease and should serve as a replacement for Temple and Fairland in commercial production. It is firmer for shipping than either of the latter varieties, and virus-free plants are available from nurseries.

Bramble-breeding continued, with stock of several selections being increased for eventual introduction.

(Project L-73)

Peaches Respond to Supplemental Irrigation

Five years' data on soil moisture and irrigation studies in a Western Maryland peach orchard have shown that periods of severe lack of moisture have occurred in three out of the five seasons. When considering total rainfall for the growing season, the figure was adequate for four out of the five years. Yet, in two of these four years supplemental irrigation was necessary because of faulty distribution of the rainfall. In the 1959 season, rainfall was above normal for the season, and yet three per-

iods occurred during peach growth when soil moisture was the limiting factor for normal growth rates of the fruits. Irrigation experiments on the Sunhigh variety indicated that a single irrigation of 1-acre-inch increased fruit growth by 13 percent.

These results point out the value of supplemental irrigation on the peach crop, and also the importance of the distribution of seasonal rainfall as the major factor which dictates when irrigation is needed. *(Project L-74)*

Chemical Weed Control Practical in Young Apple Orchards

Two years' results indicate that weeds and grasses can be effectively controlled around young apple trees with chemicals. Two methods of approach have been used:

Pre-emergence—Simazine applied at the rate of 2 pounds per acre in the early spring around young Golden Delicious trees has given good control which lasted throughout most of the season. Some late season weeds developed, but little until harvest time or later. Two years' applications of Simazine up to the rate of 4 pounds per acre on the same trees has produced no indication of injury to the trees.

Post-emergence—The application of dalapon plus amino triazole at rates of 7 and 5 pounds per acre, respectively, has produced satisfactory control of vegetation around larger apple trees. This rate applied two years in suc-

sion to Stayman and York apple trees has produced no adverse effects on these varieties. Dalapon alone at 15 pounds per acre has given good control of grasses, but little or no control of broad-leaved weeds.

In both pre- and post-emergence weed control studies, a circular area 6 feet in diameter around the tree has been treated; the amounts applied are expressed in pounds per acre in the area sprayed. The cost for materials to treat trees in this manner is currently about 65 cents per 100 trees for Simazine, and about \$1.50 per 100 trees for the Dalapon or the Dalapon-amino triazole combination. This is considerably cheaper than hand or machine cultivation, which must be repeated several times during the season to achieve comparable control of competitive vegetation. *(Project L-74)*

Method Developed for Breeding Superior Asparagus Strains

A new technique for the development of new asparagus varieties, having plants with greater uniformity in size, yield, disease resistance, etc., has passed the first stage successfully. Thus far, eleven haploid plants have been isolated, the frequency in appearance be-

ing one plant out of every 7,000 seedlings. These isolated haploid plants will be treated with the drug "colchicine" in an attempt to restore the chromosome number and thereby develop inbred lines for use in the breeding program. *(Project Q-81-c)*

Continue Work on Improving Sweet-Corn Hybrids

The work toward the development of hybrid processing varieties of sweet corn adapted to Maryland by utilizing the cyto sterile method continued. Producing hybrids by this method would eliminate the possibility of obtaining inbred seeds among hybrid seeds, and detasseling of the female inbred rows in the hybrid seed production fields would not be necessary, thereby reducing labor costs appreciably. The first phase of this work has been completed, i.e., compos-

ites are now ready for inbreeding and the selection of inbred lines.

Results from a uniform variety trial conducted cooperatively with six other state experiment stations in the Northeast for the past 5 years indicate that N.J.-106 is an excellent early market corn; N.J.-101 and F.M. cross are excellent mid-season varieties; and N.K.-199 is an excellent late maturing processing type. *(Project Q-81-c)*

POULTRY

There has been as much or more change in poultry husbandry over the past two decades as in any other agricultural commodity. Each successive change has brought about greater and greater efficiency and at the same time increased the quality of the product being produced. This is generally characteristic of American agriculture. In spite of what we feel to be a high degree of efficiency at the present time, many problems remain unanswered, the answers to which will lead to continued progress in the more efficient production of poultry meat and eggs. Some of the results of our research program are briefly presented below. None of the results in themselves are particularly startling. However, the sum of our knowledge about poultry or any other field of endeavor is the continued compilation of such bits of information. The research laboratories and field stations of the Poultry Department are open to anyone interested in poultry husbandry, and we invite all to attend our field days and discuss the research programs with us.

Study Protein and Methionine Needs of Laying Hens

During the past two years, White Leghorn pullets fed simplified corn-soybean oil meal type rations varying in protein content from 11 to 18% have responded to diets containing higher levels of protein as measured by egg production, egg size, feed intake, feed consumed per pound of egg and mortality. The addition of methionine or methionine and lysine improved the results. Using data obtained with rations limiting in methionine, an equation has been formulated which permits the calculation of the methionine requirement of the laying hen as a function of body weight, body weight change and weight of egg product. By using a similar approach in the calculation of caloric requirement as a function of body size, rate of gain, rate of egg production, egg size and season of the year, one can calculate the specific methionine level required in a ration with a given energy content to support a specified level of production under defined conditions. This approach to calculation of methionine and energy requirements for the laying hen should greatly enhance the ability of nutritionists to for-

mulate adequate rations as well as to interpret results obtained in previous experiments.

Evidence has also been obtained which indicates that appreciable "over-consumption" of feed energy and some withdrawal of body protein occurs in an attempt to maintain egg production at a high level when a ration suboptimal in effective protein is fed. Carcass analysis failed to reveal any increase in body fat in hens fed low protein rations despite the fact that their energy intake was approximately 29% more than that which was estimated to have been required. This suggests impaired absorption and/or utilization when low protein rations are fed.

During the past year, simplified corn-soybean meal type rations containing 15% protein supported 69.5% egg production on a hen-day basis during a 40-week experimental period, whereas egg production amounted to 75.5 to 76.5% when methionine was added to this ration or when a higher protein level was fed, or when the hens were allowed free-choice of the low protein ration and another containing either added

methionine or additional protein. In addition, the amount of feed required per dozen eggs was reduced by 5% with feeds containing higher protein or added methionine. It would appear that approximately 16.5 to 17% protein was needed for high production

with corn-soybean type rations not containing added methionine. The amino acid content of the ration, in relation to its energy content, appears to be the critical factor.

(Projects M-35-m, M-202)

Energy Restriction of Laying Hens Has Little Effect

Since heavy breed layers tend to gain considerable weight during the laying year, two trials were conducted in which the energy intake was restricted with otherwise identical daily nutrient intake per hen. In one of these trials, Columbian Plymouth Rocks were restricted to 87% of the energy intake of their controls, and in another, Maryland Flightless strain pullets were restricted to 81% of the energy intake of

corresponding controls. Little difference was observed in egg production, Haugh unit scores or mortality. Gain in body weight and egg size were reduced when energy intake was restricted. Observations were also made concerning blood serum cholesterol, carcass fat and moisture levels but no consistent effects were noted due to the energy restriction.

(Project M-35-m)

Increased Calcium Level Improves Egg Shells

Laying hens fed all-mash rations containing 3.0 or 3.75% calcium produced eggs having thicker shells than control hens fed rations containing 2.25% calcium as recommended by the National Research Council, even though both

calcite grit and oyster shell were supplied free-choice to all pens. These rations contained 1.25% added fat, in order to prevent excessive dustiness of the feed.

It appears that the laying hen's re-



Devices used for objective egg quality measurement.

quirement for calcium, in the presence of adequate levels of manganese and zinc, is appreciably higher than that presently recommended by the NRC

for the production of eggs with highest shell quality. No advantages were obtained from the use of vitamin C.

(Project M-35-m)

Energy Metabolism Studied in Chicks

Chicks from 2 to 4 weeks of age were fed adequate rations containing differing amounts of carbohydrate, fat and protein as sources of energy. Metabolizable energy determination of each ration and the energy and nitrogen deposited in the growing chick were measured. This involved gross energy determinations of feed and feces and of sacrificed chicks. Nitrogen determinations were made on feed and feces as well as on the total body composition at the start and end of each trial. Nitrogen corrections were made so that the metabolizable energy values would not be influenced by the percent of nitrogen retained in the carcass. Assuming that the average productive energy content of all diets in each experiment was 70% of the measured metabolizable energy values, the amount of energy used for maintenance and heat increment could

be calculated.

The results indicate that as the fat level in the diet was raised from 2 to 20% the proportion of metabolizable energy retained in the carcass decreased. Concurrently, the calculated heat increment increased and the calculated relative productive energy, expressed as percent of metabolizable energy, decreased. The decrease in energy deposited in the carcass, in relation to metabolizable Calories consumed as fat is of interest. These results do not agree with those of others suggesting that the heat increment of fat is lower than that of other energy sources. The percent of metabolizable energy retained in the carcass, corrected for nitrogen retention, decreased from 31.3 to 28.6% as the fat level was increased from 2 to 20% of the diet.

(Project M-54)

Seek Protein Level and Amino Acid Requirements of Broilers

Further studies have been conducted with broilers using rations containing slightly lower levels of protein than are normally found in broiler feeds with amino acid fortification to insure adequacy. From these results, estimates of minimal amino acid requirements in relation to the energy content of the broiler feeds have been made.

In other studies, the protein level of broiler feeds has been raised from 22 to

30% without measurably increasing the requirement for methionine. This has been done by increasing the soybean meal component in simplified corn-soy bean meal type rations. These findings suggest that the expression of the amino acid requirement, solely as a function of protein, is not satisfactory, particularly when high levels of protein are fed.

(Project M-202)

Microbiology Aids Research in Poultry Nutrition

Trichomonas gallinae, a single-celled protozoan animal, is a useful tool in fat metabolism research. Past work has shown that it requires cholesterol, as well as palmitic and oleic acids. In the most recent research, it is found to re-

quire vitamin E. Some other quinones also stimulate growth. This organism may be of use in a microbiological assay of vitamin E. It should be valuable in determining the specific functions of these compounds.

(Project M-48)

Broiler Diets Not Improved by Insoluble Grit

The results of two trials conducted during the year, together with previous results obtained at the University of Maryland, fail to show any need for the use of insoluble grit in present day high-energy, all-mash broiler feeds. Although slight improvements in feed conversions and, in some cases, body

weights were observed, the difference in body weight and most of the difference in feed efficiency can be explained on the basis of the increased weight of the broiler due to its grit content. These studies have failed to reveal economic benefits from the use of insoluble grit.

(Project M-200)

Work Continues on Developing Efficient, Practical Broiler Feeds

Studies have continued in the development of simplified efficient corn-soybean meal type rations for broilers. These improved rations are based on the results of studies conducted at the University of Maryland on amino acid requirements and improved protein quality, vitamin levels, "unidentified factor" supplements, potency and improved nutritive balance.

During the past year, these studies

have included additional work with "unidentified growth factors;" supplemental vitamins, including vitamin C, biotin, pyridoxine, and folacin; comparison of fats from different sources; evaluation of various fats; effect of pelleting rations of different energy potency, and studies involving coccidiostats and arsenicals.

(Projects M-202, M-200)

Study Relation of Temperatures and Nutritional Needs

In studies with broilers held at temperatures between 50 and 90° F., increasing the levels of B complex vitamins and/or minerals failed to alleviate the depressed growth at either cold or hot temperatures. Diets containing higher levels of fat appeared to give slightly better results in some trials, although this difference is believed to be due primarily to increased nutritional potency

of the rations. When fat levels were varied in isocaloric rations, no effects were observed. Higher protein levels appeared slightly beneficial with both low and high temperatures. This effect at the low temperatures, however, is believed to be a result of increased oxidation of protein due to the caloric insufficiency induced. *(Project M-200)*

Investigate Perosis in Chicks

Work continues to determine factors which affect perosis in the chick. Recent findings have indicated that estrogens and sedatives alleviate bone anom-

alies caused by folic acid deficiency. In addition, it would appear that excess dietary protein aggravates the condition. *(Project M-204)*

Compare Antibiotics in Broiler Diets

Comparative tests with broiler chicks were run using new antibiotics and those long in usage. All stimulated growth markedly, and there was little evidence to indicate that the "older"

antibiotics were losing their effectiveness. Antibiotics tested were tylosin, oleandomycin, spontin, terramycin, zinc bacitracin, procaine penicillin and erythromycin. *(Project M-201)*

Establish Need for Trace Minerals in Poultry Nutrition

Further studies have been made to more firmly establish the need for supplementary zinc in practical turkey feeds. Some benefit in growth, together with improved feather development and hock condition, was obtained in nearly every instance where zinc was added to the usual type of corn-soy starting ration. Quantitative tests indicated that the addition of 50 ppm zinc in this type of ration would provide for maximum growth and hock and feather development.

Continued work in which White Leghorn hens were fed highly purified diets has shown that zinc is essential for proper embryonic development. Embryos of eggs from hens fed a zinc-deficient diet for extended periods frequently exhibit characteristically deformed skeletal structures and incomplete skin closure which leaves the viscera exposed.

Studies with magnesium in the diet of chicks and both magnesium and potassium in turkey poult feed have revealed that the amount of these minerals needed in the diet is reduced when the feed contains a growth-active anti-

biotic. The "sparing effect" of antibiotics was particularly impressive in the tests of the potassium requirements of pouls, 25% less potassium being needed for maximum growth in the presence of an antibiotic.

Due to the fact that high dietary calcium levels interfere with the absorptions of manganese, zinc and perhaps other elements (notably phosphorus), further study has been initiated into the feasibility of reducing the calcium level in turkey rations. Preliminary results have indicated that this may well be possible, maximum growth and bone ash having been obtained in all tests, so far, with calcium levels considerably lower than the 2% recommended by the National Research Council.

Unknown Growth Factor. Preliminary work in which 5 to 10 ppm of indole-3-acetic acid was added to chick and poult rations suggested that this plant hormone might function as a growth stimulant in poultry rations. Considerable further study will be needed to determine the significance of these observations. (Project M-203)

Develop Lines with Genetic Differences in Blood Serum

By selective breeding, it has been possible to develop lines of chickens that have high or low levels of cholesterol or of alkaline phosphatase in their blood serum. The reason for doing this is to determine if improvement in performance of the birds, as measured by egg production, egg quality, growth rate, etc., could be made by selecting for a difference in a chemical in the serum rather than by selecting for the traits themselves. Records on birds of high and low cholesterol lines have revealed very little difference in the performance of these lines, except that the birds of the low line start laying sooner than those of the high line. Other experiments have shown that these lines

also differ in the level of other lipids in their serum, that they differ in blood pressure, but do not differ in the cholesterol level of their yolks.

In other studies with a line bred for high alkaline phosphatase, the rate of egg production has been slightly higher in this line than in a control stock, but there was very little difference in the performance of this line. In experiments to find the cause for the high level of alkaline phosphatase in this line, it has been found that it also has a high level of the enzyme in its kidneys and that it responds differently to thyroxin than does the control stock.

(Projects M-32-m, M-33-e)

Study Chicken Growth Inhibitors

Studies have continued on the growth-depressing effect of hemin, protoporphyrin and hematoporphyrin. The first two compounds resulted in bowed legs in a large percentage of the survivors. These bone deformities are being studied to see if they are related to other known bone conditions, such as rickets.

The observation that benzimidazole compounds were inhibitors for chick

embryo development led to the suggestion that the compounds might slow sperm metabolism and thus improve sperm preservation. Inhibitor levels which inhibited motility of the sperm prolonged the fertilizing capacity of the sperm. The storage period for chicken semen was extended to 3 days with excellent fertility with 2,5-dimethyl- and 2-ethyl-5 methyl benzimidazoles.

(Project M-49)

Seek Improved Methods for Detecting Meat Spots in Eggs

Because the pigment of the shell and meat spots are the same, it becomes difficult to devise methods of detecting these spots in eggs. In blood spots the pigment is different from the shell so detection devices can be devised. Analyses show that the meat spots also have considerable calcium, as has the shell. Although detection devices would greatly reduce labor and improve efficiencies, the real problem is to reduce

the incidence of occurrence of these abnormalities.

Along with some other studies, the incidence of blood and meat spots has been determined on birds on rations containing high levels of vitamins A and C, but no differences have been observed. All hens on experiment at this station are continually checked in case some study may give a clue to this problem.

(Project M-51)

Does High Ambient Temperature Affect Shell Thickness?

Studies have been continued to determine why egg shells become thinner during high summer temperatures. Previously, studies indicated that those hens that had less acidity in the blood (lower pH) had better shells.

Therefore, studies were initiated to determine if the alkali reserve in the blood has any correlation with shell

thickness. The studies so far do not indicate that any such correlation exists. Since hardly any data are available on the alkali reserve of the blood, it is believed that the normal pattern during the laying year should be established, contributing to basic knowledge of chicken blood.

(Project M-53)

Bleeding Time Influences Carcass Color

Carcass discoloration is a serious problem since it leads to considerable downgrading or a high condemnation rate of processed poultry. Studies were made to determine possible causes of this discoloration and methods of preventing it.

Initial work indicated that bleeding time affects carcass discoloration. Broilers bled for only 30 seconds have much

more discoloration than those bled for 60 seconds. A bleeding time of 90 seconds almost completely eliminates the problem of carcass discoloration.

Two gases, carbon dioxide (CO_2) and nitrogen (N_2), were investigated as to their ability to render the bird unconscious and the resultant effect on carcass discoloration. It was found that both served to considerably decrease the

leath time and the variability in death time. The average death time of birds bled under normal conditions was 122 seconds and can range as high as 168 seconds. In contrast, the average death time of birds bled in a 100% atmosphere of CO₂ was 58 seconds and may range only as high as 70 seconds. The application of a 100% atmosphere of either CO₂ or N₂ for as little as 20 seconds tends to eliminate the problem of carcass discoloration.

The data presented herein indicate that a method of insuring the death of the bird in a very short time, thus reducing the bird's activity, would elimi-

nate the problem of carcass discoloration caused by short bleeding times.

Other preliminary work has been initiated on temperature and other factors which could also affect carcass discoloration.

Another area that has been investigated is carcass yield. Statistical analyses revealed that broiler yields could be quite accurately predicted by a formula calculated from the condemnation rate. Preliminary checks indicate that carcass yields can be predicted, without weighing the birds, within 1% about 90% of the time.

(Project M-100)

Breed Medium-Sized Turkeys for Economic Traits

A strain of turkeys has been developed which has especially good reproductive capabilities as well as good viability and rate of growth. These birds have been selected over the past 10 years from crosses between Broad-Breasted Bronze and Beltsville White birds.

Most of the selection pressure has been for improvement in the reproduc-

tive capacity to lower poult cost. At 24 weeks of age, the males average about 20 pounds and the females, 12 to 13 pounds each. This size of turkey finds a ready market.

The birds have been made available to commercial producers who are incorporating them into their strains of commercially available turkeys.

(Project M-34-e)

Study Mechanisms Controlling Molt

When molt takes place in normal birds, lay is usually interrupted. However, it has not been possible to say whether the demands of egg formation finally lead to molt or if the molt would occur quite irrespectively.

To decide the question, the oviducts of pullets were surgically separated in the region of the magnum. As hens, these birds regularly formed yolks that were shed into the body cavity where they were absorbed. Since these hens

could not produce eggs, they were spared these claims on their body economy. The operated birds came into molt at the same time as the control hens; internal inspection showed that yolk formation was interrupted in both groups for a period.

This shows that the ovulatory cycle and molt are associated and that the onset of molt is not influenced by the direct demands of egg production.

(Project M-32-L)

Effect of Ambient Temperature on Broiler Production Tested

Studies have continued on the effect of ambient temperatures on the efficiency of broiler production. Five battery tests were conducted using temper-

atures from 50° to 90° F. and employed different Calorie-protein ratios. In general, at 50° F. the average gain was only 77% of that when 75° F. was

maintained, yet feed consumption was 7% greater at 50° F. The higher temperature almost doubled carcass fat (31% versus 14%), these observations showing clearly that under battery conditions the higher temperature was better insofar as feed efficiency was concerned. In floor pen studies, 16 pens of 400 birds each were reared to 5 weeks of age under conventional temperature conditions. From 5 to 8½ weeks of age, one half of the pens were subjected to

temperatures of 65° F. and the other half of the pens to a temperature of 53° F. There was no appreciable difference in the rate of gain which resulted, nor in the resulting feed conversion at the two temperatures. This, in contrast to the results above, indicates that low temperatures under battery conditions are far more harmful than under floor pen conditions.

(Project M-301, NE-8)

Chickens Show Color Perception and Preference

Although the hen, according to the textbooks, is not supposed to be able to perceive differences in color, work at this station has shown that at least certain hens have a preference for the color of the nest in which they lay their eggs. By allowing birds choices of nest colors at different locations, it was found that about 75% of the White Leghorn chickens have a distinct color recognition and preference; and 25% of the birds have little or no preference,

at least for different colors. The colors of blue and pink were most often preferred. However, an occasional bird was found that preferred yellow. These results largely confirm our previous reports on color preference. Work the past year has been with a small group of inbreds which uniformly have shown more pronounced color preference than birds previously used.

(Project M-55)

Best Storage of Chicken and Turkey Semen Sought

Several experiments have been conducted in an attempt to find out more about the best conditions for storage of chicken and turkey semen. It was found that the addition of $MgCl_2$ to a phosphate diluent had little effect on fertility, although addition of KCl reduced it slightly. Addition of large amounts of $NaCl$ reduced it markedly.

Two alkyl-benzimidazoles which inhibit motility were found to be useful for long term storage. When they were washed from the sperm after storage by using centrifugation, motility resumed. Using this procedure, a surprisingly

high fertility of 60% was obtained after 5 days' storage. They also appear to be useful for the storage of turkey semen. Other work has been conducted on the metabolism of carbohydrates by the sperm; fructose, mannose and glucose were utilized to a greater extent than the other carbohydrates studied. Further work is planned on the use of other inhibitors for long term storage of chicken semen in the hope that an inhibitor can be found that is even more effective than the ones already used.

(Project M-300)

VETERINARY SCIENCE

Research projects are chosen on the basis of the importance of the disease in relation to the economics of the livestock and poultry industries and to the health of the human population.

Some research studies are also carried out to determine whether or not full scale projects are justified for the future.

Test New Diagnostic Method for Infectious Bronchitis

Infectious bronchitis is a prevalent and troublesome respiratory disease of chickens. Although drugs effective against this disease have not been found, vaccination is widely practiced in growing-stock as a preventive measure. Since several different respiratory diseases exhibit similar symptoms, an accurate diagnosis is essential to selection of the proper vaccine. Investigational work currently is under way to develop a more rapid and economical diagnostic test than the serum neutralization test

currently employed. It has been found that blood serum containing infectious bronchitis antibodies will produce an agglutination reaction with infectious bronchitis virus absorbed on the surface of red blood cells previously treated with tannic acid. Comparative tests with the serum neutralization and the new method (passive hemagglutination) are being conducted on artificially and naturally infected chickens to determine the relative efficiency of the rapid test. *(Project D-52)*

Improved Diagnostic Methods and Interpretation Used for EEE

Research findings on diagnostic methods and interpretations obtained from experiments in horses and chickens at the University of Maryland, were applied to the 1959 epizootic of Eastern equine encephalomyelitis (EEE). As a result, early cases of the disease in Maryland and Pennsylvania were detected and reported immediately, thus enabling wide-scale vaccination which conceivably prevented cases which otherwise would have occurred.

Surveillance of the infection, continued in cooperative studies with the

University of Maryland's Department of Entomology and federal agencies, failed to detect the virus in mosquitoes but revealed its presence in domestic sparrows. EEE virus was also recovered during an outbreak of disease in chukers near Salisbury, Maryland.

Although there were 33 human cases of the disease in 1959, with 21 deaths, only one human was affected in Maryland. Distribution of the disease in Maryland followed the same pattern as in previous years. *(Project D-57)*

Trace Distribution of Mastitis Bacteria

Nine herds have been followed to determine the range of host-organisms involved in quarter milk samples. The method included: (1) a direct-tube bacteriological culture (Agricultural Ex-

periment Station Report, June 1959); (2) the California mastitis test for white blood cells; and (3) inoculation of seven-day-old embryonated eggs. Those samples which showed an ele-

vated number of white blood cells, but which were bacteriologically negative, were inoculated into the allantoic cavity of chick embryos. Out of 1,164 quarters, 352 had an abnormally high number of white cells in the milk. Fifty of these samples, not associated with bacteria, were inoculated into a series of embryonated eggs, and passed at least three times.

In a group of 119 herds, cows were

found to be infected in one, two, three and four quarters in the ratio of 8:4:2:1 suggesting a standard which will be useful in the analysis of environmental factors in mastitis.

The range of bacterial agents in over 90% of the infected quarters included *Streptococcus agalactiae*, hemolytic *Staphylococcus* sp., *E. Coli* and *Pseudomonas* sp. (Project D-58)

Investigate Air-Sac Disease in Poultry

The bacterial flora of the respiratory system of poultry associated with PPLO (pleuropneumonia-like organism) in air-sac infection (aerosaccitis) have been studied as a means of evaluating secondary infection and as a guide to administration of therapeutic agents. Gram-negative organisms, for the most part *Escherichia coli*, were isolated from the sinus, nasal passage, trachea, lungs and air-sacs. In some cases, gram-positive organisms of the genera *Streptococcus*, *Staphylococcus* and *Micrococcus* also were found. In a few instances members of the genera *Lactobacillus*, *Corynebacterium*, *Bacillus* and *Aspergillus* were isolated. *E. coli* was isolated from pericardial tissue, but PPLO was

not found in the heart-sac. Mixed infection thus is implicated in the etiology of aerosaccitis, and broad spectrum antibiotics are indicated. The PPLO strains isolated in these studies are divided into three groups on the basis of carbohydrate fermentation. Pathogenic strains of PPLO form smooth colonies on agar while non-pathogenic strains exhibit colonies with a raised nipple-like center. Current investigations are being conducted for the purpose of classifying avian PPLO serologically and preparing a test fluid (antigen) that may be used to detect disease carriers in Maryland poultry flocks and counteract egg-transmission of the disease.

(Project D-59)

Study Pathology of Breeding Failure of Cattle

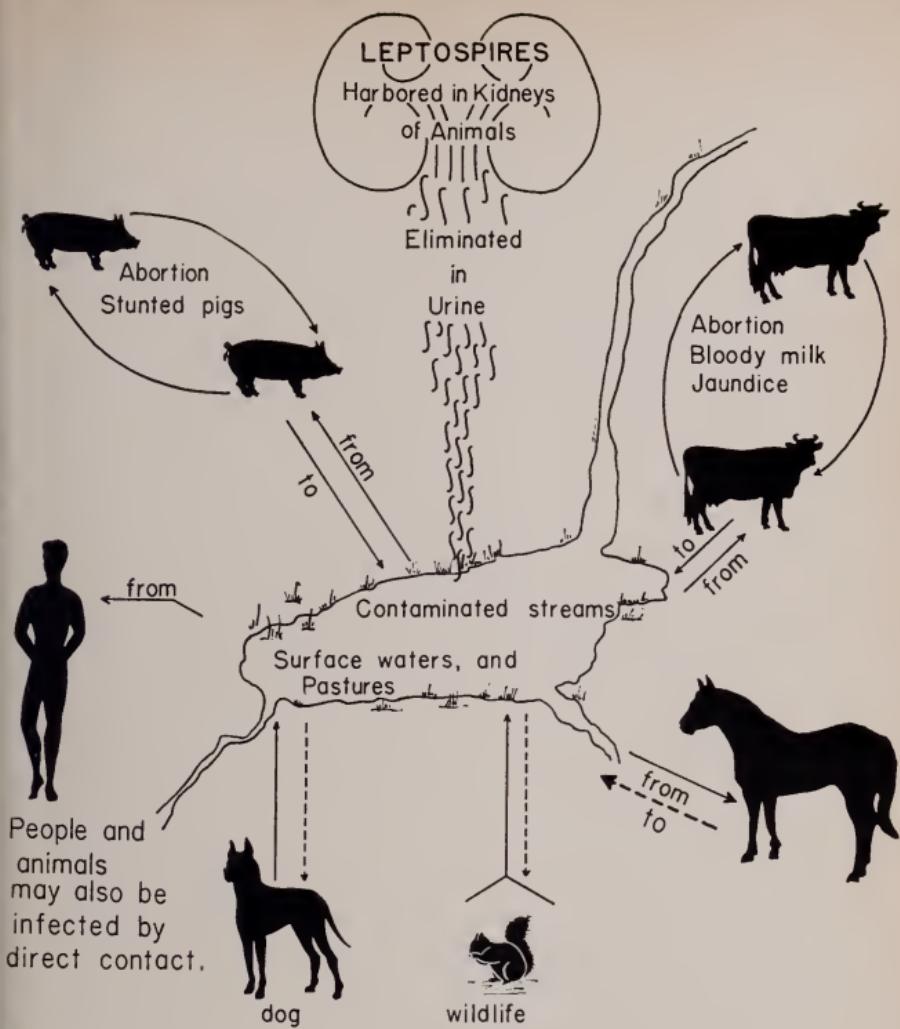
Vibriosis—The direct isolation of vibrio causing infertility from carrier bulls is an uncertain procedure that is time consuming and requires large quantities of culture media. The presence of other contaminating bacteria that overgrow the vibrio has been the principal problem. Using a new filtration technique, *Vibrio fetus* has been isolated from 12 of 14 samples taken from a known positive bull. The bacteria that hinder the isolation of vibrio have been eliminated by this technique in 56 of 63 samples included in 219 trials.

Heretofore it has been necessary to culture from virgin heifers bred to sus-

pected carrier bulls. This procedure required four weeks before a reliable diagnosis was completed. Preliminary results indicate that the reliability of the new method may approach 100% and require 10 ten to complete.

Fifteen of fifty bile samples obtained from adult cattle at slaughter contained a strain of vibrio. The biochemical relationship of these isolates to strains isolated from the genital tracts of cattle with infertility problems is being studied.

Leptospirosis—Leptospirosis continues to be a serious problem in Maryland cattle and is characterized by abortions, bloody urine and drop in milk produc-



Methods by which leptospirosis may be spread.

tion. Calves may become weak and stunted and frequently die from the disease. Research efforts have been directed toward studying epizootiological characteristics of the infection, determination of leptospiral strains causing disease, laboratory methods of detecting carrier animals and evaluation of vaccines.

Work to date indicates that a number of leptospiral strains infect Maryland cattle, although *Leptospira pomona*

appears to be the most significant cause of the disease. A recently developed agar-plate method for cultivating leptospires may be useful in detecting urinary carrier animals.

Vaccination against *L. pomona* infections is indicated in many situations and in general, immunized animals do not develop serum titers which could interfere with control programs or epizootiological surveys.

(Project D-62)

Study Confirms Non-Sterility of Cattle Embryos

A survey of some 500 fetuses, obtained from apparently normal cows at slaughter, has been completed during the past year. The 3- to 6-month-old fetuses were removed from the intact uteri and the organs and tissue were cultured on six different media, in embryonating eggs and in laboratory animals.

Only thirteen of the fetuses studied were sterile, and many of the embryos contained more than one kind of bacteria. As many as seven different organisms were isolated from a small percentage of the fetuses. More than twice as many bacteria were isolated from the skin of the embryos than from any other organs or tissues. Cultures of the amniotic fluid were few; but the liver, spleen, kidney, heart blood, and stomach contents all showed appreciable numbers of organisms. These isolates consisted of a wide variety of bacteria, many of which were not disease producing.

Brucella were found to be present in four per cent of the embryos examined. The largest percentage of this organism was obtained from the skin, but isolations were also made from the stomach contents and suspensions of ground tissues and organs. Many of the dams, harboring infected embryos, had Brucella agglutination reactions; but isolations were made from the fetuses of completely negative animals as well.

Using special techniques adapted for the isolation of Leptospira, no evidence was found to indicate that these organisms were present in the normally developing fetuses, although many of the dams had high reactions in the test used for diagnosing the disease.

Identification of the bacteria found in 100 fetuses was attempted, and more than 200 organisms were partially or fully identified. In addition to Brucella, a number of disease-producing organisms were found, but most of the bacteria were non-pathogenic. A large number did not fall into the normal classification patterns and probably had been modified because of living in embryonic tissue.

This survey presents further proof that cattle embryos *in utero* are not generally sterile, as was formerly believed, but contain a variety of organisms, sometimes in very large numbers.

The studies on the development and evaluation of immunizing agents for brucellosis of cattle have been continued. The egg-adapted vaccines developed over the past three years appear to be quite effective in laboratory animals, but they must be studied in cattle. Additional data has been acquired on the protective qualities of the blood sera in cattle, as measured by the death times in embryonating eggs.

(Project D-60)

Search for Causes and Cures in Bovine Respiratory Disease

Bovine Respiratory Disease (shipping fever) is responsible for heavy losses in feed lots and other places where cattle are assembled. In addition to being subjected to severe stress in transit, animals are exposed to a number of infectious agents. As a result, many cattle develop fever and other signs of illness which may culminate in unthriftiness, pneu-

monia and death.

Experiments have been conducted at the University of Maryland to determine what infectious agents are involved in shipping fever, their pathogenicity in experimental animals and the feasibility of vaccination.

(Project D-63)

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FINANCIAL STATEMENT -- JULY 1, 1959, TO JUNE 30, 1960

Federal Funds—Under Hatch Act Amended

Appropriation 1959-1960	Amended Hatch		Regional Agr. Marketing Title II		For Agricultural Investigations
	\$ 345,414.00	\$ 99,525.00	\$ 725.65	\$ 11,800.00	
TOTALS	<u>345,414.00</u>	<u>99,525.00</u>	<u>12,525.65</u>	<u>11,800.00</u>	<u>1,430,168.03</u>
<i>Receipts from Other Sources 1959-1960:</i>					
State Appropriations for Agricultural Investigations.....	244,390.24	70,745.28	10,728.75	945,439.07	
Personal Services.....	6,745.31	2,581.38	247.54	15,190.84	
State Endowments, Fellowships and Grants.....	335.66	75.16	.....	74.50	
Sales and Miscellaneous.....	560.93	123.95	35.86	4,766.45	
Balance brought forward July 1, 1959.....	1,797.38	479.91	.....	17,282.59	
TOTAL	<u>345,414.00</u>	<u>99,525.00</u>	<u>12,525.65</u>	<u>1,430,168.03</u>	
<i>Expenditures:</i>					
Personal Services.....	244,390.24	70,745.28	10,728.75	945,439.07	
Travel.....	6,745.31	2,581.38	247.54	15,190.84	
Transportation.....	335.66	75.16	.....	74.50	
Communication Service.....	560.93	123.95	35.86	4,766.45	
Rents and Utility Services.....	1,797.38	479.91	.....	17,282.59	
Printing and Reproduction.....	1,755.83	3,768.31	.....	6,755.76	
Other Contractual Services.....	5,754.11	2,174.78	.....	42,497.88	
Supplies and Materials.....	45,094.91	8,609.63	.....	271,335.72	
Equipment.....	38,841.23	10,967.10	634.01	67,936.47	
Lands and Structures.....	138.40	.....	.....	3,007.57	
Contributions to Retirement.....	.....	.....	.....	.....
Taxes and Assessments.....	.....	.....	.....	.....
Balance June 30, 1960.....	<u>345,414.00</u>	<u>99,525.00</u>	<u>12,525.65</u>	<u>1,430,168.03</u>	
TOTALS	<u>345,414.00</u>	<u>99,525.00</u>	<u>12,525.65</u>	<u>1,430,168.03</u>	

* Including Offset Funds

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CURRENT PROJECTS

(These are projects and not publications available to the public)

Department of Agricultural Economics and Marketing

Project No.

A-18-am An Analysis of Alternative Adjustments in Farm Organization. Sidney Ishee and G. N. Nuckols, Jr.

A-18-an An Economic Analysis of Cage and Floor Methods of Commercial Egg Production. R. A. Murray.

A-18-ao An Analysis of Forage Storage on Dairy Farms. J. W. Wysong and J. F. Gale.

A-18-ap Economic Profitability of Vegetable Production in Maryland. Sidney Ishee.

A-18-aq Economic Effects of Vertical Integration on the Production and Marketing of Maryland Farm Products. Sidney Ishee.

A-18-ar Economies of Scale in the Production of Fluid Milk on Specialized Dairy Farms in Maryland. J. W. Wysong and Roland Robinson.

A-19-u The Effects of Property Tax Assessment and Exemption Practices on Maryland Farmers and on State Aid Equalization Programs. W. P. Walker, Sidney Ishee and Reese Poffenberger.

A-19-v An Analysis of the Distribution of Highway-User Taxes for Rural and Urban Highways in Maryland. W. P. Walker.

A-26-am Alternative Merchandising and Promotional Methods Affecting Demand for Poultry Meat. H. D. Smith and C. P. Eley.

A-26-aw Pooling Arrangements and Quota Plans in Maryland Fluid Milk Market. G. M. Beal and K. N. Adams.

A-26-ax Market Outlets and Methods of Marketing Chickens and Turkeys from Farm Flocks. H. D. Smith, R. J. Beiter and L. H. Davis.

A-26-ay Improving Techniques of Market Preparation and Grading of Maryland Tobacco. G. M. Beal, Morley Jull and Keith Park.

A-26-az An Economic Analysis of Soybean Marketing in Maryland. R. E. Beal, Bhagwant Singh and C. C. Taylor.

A-26-b Membership Relations and Educational Programs of Farmer Cooperatives in Maryland. R. J. Beiter and Graduate Assistants.

A-26-ba Sales Organizational Aspects of Quality Control in the Marketing of Fruits and Vegetables. D. A. Swope and F. R. Todd, Jr.

A-26-bb Impact of Recent Trends in Specification Production and Buying of Livestock on Market Organization and Services. H. D. Smith and J. N. Smith.

A-26-bc Adjustments of Maryland Milk Processing-Distribution Systems and Practices to Changing Conditions. G. M. Beal.

A-32-j Problems Associated with Farm Irrigation in Maryland. L. B. Bohanan and Sidney Ishee.

A-34 An Analysis of the Processing and Marketing Costs for Selected Processing Vegetables Grown in the Tri-State Area. D. C. Burns, L. C. O'Day, Roger Burdette and D. A. Swope.

Department of Agricultural Education

T-4 The Role of Educational Campaigns in Removing Safety Hazards from Farms. H. P. Hopkins and A. M. Ahalt.

T-5 Improving Agricultural Community Shows and Exhibits. H. P. Hopkins.

T-6 Identification of High School Educational Experiences Affecting the Success of Students in the College of Agriculture. C. R. Smith and Glenn Baird.

Department of Agricultural Engineering

R-11-d Tobacco Housing. P. N. Winn, G. J. Burkhardt, O. E. Street and J. H. Hoyert.

R-11-e Structures and Equipment for Tobacco Stripping. P. N. Winn, G. J. Burkhardt, O. E. Street and J. H. Hoyert.

R-16 Pneumatic Handling of Chopped Forage. K. E. Felton, G. J. Burkhardt, E. W. Martin and J. E. Foster.

R-18 Development of Equipment and Improved Methods for Harvesting Sweet Potatoes. G. J. Burkhardt, E. W. Martin, N. T. Martin and L. E. Scott.

Department of Agronomy

B-43 Soybean Varietal Improvement. R. C. Leffel and W. D. Hansen.

B-50 Breeding for Better Dent Corn. R. G. Rothgeb and staff assistants.

B-56-g Ladino Clover Breeding Disease and Insect Investigations. R. C. Leffel.

B-56-i Orchardgrass Breeding Investigations. R. C. Leffel.

B-56-j Pasture Species for Beef Production. A. M. Decker, Jr. and J. E. Foster.

B-56-n Alfalfa and Alfalfa-Orchardgrass Management. A. M. Decker, Jr.

B-66 Wheat Breeding and Evaluation. R. G. Rothgeb, J. L. Newcomer, J. H. Axley and staff assistants.

B-67 Varietal Improvement in Barley and Oats. R. G. Rothgeb and staff assistants.

B-68 Effect of Rotational Practices Involving Various Legumes on the Growth, Quality, and Composition of Maryland Tobacco. O. E. Street, C. G. McKee, J. H. Hoyert, J. E. McMurtrey and J. D. Bowling.

B-69 Breeding for Mildew Resistance in Wheats Useful in the Northeast. R. G. Rothgeb and staff assistants.

B-70 A Study of the Growth Characteristics of Foxtail (*Setaria spp.*) as Related to Chemical Control Measures. P. W. Santelmann and J. A. Meade.

B-71 Performance of Grain Sorghum Hybrids in Maryland. R. G. Rothgeb and staff assistants.

B-72 Evaluation of Varietal Purity and Identity of Seeds of Improved Strains of Alfalfa. J. L. Newcomer.

B-73 Clipping Management Effects on the Productivity and Persistence of Perennial Grasses Under Two Nitrogen Levels. A. M. Decker, N. A. Clark and J. T. Raese.

B-74 The Effects of Nitrogen Rates and Clipping Frequency on the Performance of Midland Bermudagrass (*Cynodon dactylon (L.) Pers.*) A. M. Decker.

B-75 Use of Sod-seeded Forage Crops to Supplement Existing Permanent Pastures. A. M. Decker, F. G. Swain, W. C. Hulburt and A. L. Steinhauer.

B-76 Red Clover Breeding Investigations. R. C. Leffel.

B-77 Forage Crop Variety Evaluation in Maryland. R. C. Leffel, A. M. Decker, Jr. and N. A. Clark.

B-78 The Control of Weeds in Cultivated Crops, Turf and Brush. P. W. Santelmann and J. A. Meade.

B-79 Use of Herbicides to Control Weeds in Forages. J. A. Meade and P. W. Santelmann.

B-80 Physiological and Ecological Investigations of the Effect of the Herbicides on Plants. J. A. Meade and P. W. Santelmann.

B-81 Preplant Herbicides for Tobacco Plant Beds, and Their Influence on Seedling Production. O. E. Street, O. D. Morgan, Jr., J. H. Hoyert, J. E. McMurtrey, Jr. and H. E. Heggstedt.

B-82 Fertility and Clipping Management Effects on the Productivity and Persistence of Annual Pasture Grasses. N. A. Clark.

B-83 Forage Crop Development Under Controlled Soil Temperature Conditions. A. M. Decker, Jr. and N. H. MacLeod.

BG-1 The Comparison of Nitrogen Fertilized Grasses with a Grass-legume Mixture for Lactating Dairy Cows. (In cooperation with Dairy Department). N. A. Clark, A. M. Decker, Jr., R. E. Wagner, R. W. Hemken, R. F. Davis and J. I. Leslie.

BOQR-84 Climatological Relationship to Plant Growth Employing Supplemental Irrigation. (In cooperation with Horticulture and Agricultural Engineering Departments). O. E. Street, A. M. Decker, Jr., Edward Strickling, F. C. Stark, R. L. Green, P. W. Winn, L. D. Nelson, H. H. Engelbrecht and M. L. Blanc.

BQ-83 Yield and Quality of Selected Crops Receiving Supplemental Irrigation Including Relationships of Moisture to Species, Fertilizers and Cultural Practices. (In cooperation with the Horticulture Department). A. M. Decker, Jr., Edward Strickling and O. E. Street.

O-48 Morphologic Studies of Maryland Soils as Related to Classification and Correlation. G. A. Bourbeau, H. Y. Tu and W. M. Winant.

O-54 Clay and Secondary Mineral Genesis in Maryland Soils. G. A. Bourbeau and Shiraj H. Khan.

O-55 Soil Test Studies. John Axley.

O-56 Factors Affecting the Formation and Destruction of Soil Aggregates. Edward Strickling, R. O. Gifford, A. W. Conaway and G. J. Malley.

O-57 A Study of Ammonium as a Fertilizer and Ammonium Retention in Soils. John Axley and J. O. Legg.

O-59 Response of Orchardgrass to Various Rates and Ratios of Potassium and Nitrogen Fertilization. C. B. Kresge.

O-60 The Effect of Various Rates and Frequencies of Potassium Applications on Yield, Persistence and Chemical Composition of Alfalfa and Alfalfa-Orchardgrass. C. B. Kresge.

O-61 Comparison of the Effect of Several Nitrogen Sources on Yield and Nitrogen Content of Grass Under Field Conditions. C. B. Kresge.

O-62 The Response of Forages and Certain Grain Crops to Fertilizers as Related to Rates and Ratios and Methods of Application. John Axley.

O-63 Response of Orchardgrass to Various Sources of Nitrogen and Their Time of Application. C. B. Kresge.

O-64 Response of Bermudagrass to Various Rates and Ratios of Potassium and Nitrogen Fertilization. C. B. Kresge, A. M. Decker, Jr. and N. A. Clark.

Department of Animal Husbandry

C-14 A Study of the Productiveness of Purebred Beef Cattle in Maryland. W. W. Green, John Buric, J. E. Foster and J. B. Lingle.

C-14-a Effect of Early Weaning on the Duration of Maternal Influences in Beef Calves. W. W. Green, J. E. Foster and John Buric.

C-14-d Group Versus Individual Feeding of Weaned Beef Calves. John Buric, J. E. Foster and W. W. Green.

C-21 The Effect of Specific Metabolites Upon Growth Rate and General Condition of Sheep. E. C. Leffel, W. H. Brown, S. M. Meredith and J. E. Foster.

C-23 A Study of the Effects of Protein Level on the Reproductive Performance of Female Swine. E. P. Young, F. C. Wingert, S. H. Fowler, W. W. Green and J. E. Foster.

C-24 A Study of the Presence and Control of Internal Parasites in Swine. E. P. Young, F. C. Wingert, S. H. Fowler, W. W. Green, J. E. Foster and J. R. Sperry.

C-25 A Study of Rumen Metabolism in the Sheep. E. C. Leffel, W. H. Brown, R. J. Komarek, L. W. Smith and J. E. Foster.

C-25-a The Effects of Roughage Preparation. E. C. Leffel, R. J. Komarek, L. W. Smith, S. M. Meredith and J. E. Foster.

C-26 Studies of the Protein and Energy Requirements of Growing-Fattening Swine. E. P. Young, E. C. Leffel, G. F. Combs and J. E. Foster.

C-27 A Study of Growth Promoting Properties of Certain Feed Adjuvants. E. P. Young and J. E. Foster.

C-28 A Study of the Effect of the Form in Which Feeds are Fed to Swine. E. P. Young and J. E. Foster.

C-29 A Study of the Effects of Method of Feeding and of Different Protein Supplements for Growing-Fattening Swine. E. P. Young and J. E. Foster.

C-31-a Comparison of Pelleted versus Unpelleted Barley for Feeding Weaned Beef Calves. John Buric, J. E. Foster and E. C. Leffel.

C-31-b Comparison of Morea versus Oil Meal as a Supplement for Feeding Weaned Beef Calves. John Buric, J. E. Foster and E. C. Leffel.

C-32 A Study of the Value of Systemic Insecticides in the Control of Ox Warbles, *Hypoderma lineatum* (DeVill.) and *H. bovis* (L.). John Buric, J. E. Foster, E. C. Leffel and W. J. Johnson.

C-33 A Study of the Effect of Menhaden Fish Meal on the Quality of Protein of Swine Diets and on Total Crude Protein Requirements for Growth of Swine. E. P. Young, J. E. Foster, D. G. Snyder and Robert Kifer.

Department of Botany

F-12 The Native Plants of Maryland, Their Occurrence, Distribution and Economic Importance. R. G. Brown.

F-15-b Spontaneous and Induced Multiple Seedlings and Haploids of *Zea Mays Capsicum Frutescens* and Other Economic Plants and Their Use in Plant Breeding. D. T. Morgan, Jr., R. D. Rappleye and graduate assistants.

F-16 Cycological and Genetical Studies in Ornamental and Crop Plants. D. T. Morgan, Jr. and R. D. Rappleye.

F-17 Forest Tree Improvement by Chromosome Doubling of Haploid Sporophytes. R. D. Rappleye.

J-91 Fungicidal Materials on Cellular Metabolism and Their Usefulness for the Field Control of Vegetable Diseases. C. E. Cox, H. D. Sisler, J. G. Kantzes and graduate assistants.

J-93 Treatment of Soil and Underground Parts of Plants for the Control of Plant Diseases. O. D. Morgan, C. E. Cox, W. R. Jenkins, J. G. Kantzes and J. B. Wilson.

J-95 Development of Improved Strains of Maryland Tobacco Resistant to Diseases. (In cooperation with Agronomy Department). O. D. Morgan, O. E. Street, J. H. Hoyert and assistants.

J-96 Occurrence, Distribution, Biology and Control of Plant Parasitic Nematodes in Maryland. W. R. Jenkins, J. G. Kantzes, O. D. Morgan and graduate assistants.

J-97 Biology and Control of Nematodes Associated with Plant Diseases. W. R. Jenkins, R. A. Rohde and graduate assistants.

J-98 Identification, Characterization and Control of Certain Viruses Affecting Economic Plants in Maryland. H. D. Sisler, O. D. Morgan and C. E. Cox.

J-99 The Nature and Control of Root Rots Involved in Decline of Boxwood and Other Woody Ornamental Plants in Maryland. J. B. Wilson, W. R. Jenkins and graduate assistants.

J-100 Nature and Control of Major Field and Storage Diseases of Sweet Potatoes in Maryland. J. G. Kantzes, C. E. Cox and graduate assistants.

K-8-c Biophysical and Biochemical Factors in Plant Nutrition. H. G. Gauch, R. W. Krauss, Raymond Galloway and Martin Mathes.

Department of Dairy Husbandry

G-34 Chemical Changes in Milk Fat as Related to the Flavor of the Milk. R. L. King and W. F. Williams.

G-35 The Analysis of Dairy Products. Mark Keeney, J. F. Mattick and Ira Katz.

G-37 Physiology of Metabolic Disease of Cattle. W. F. Williams, R. W. Hemken, R. F. Davis, W. H. Choate, H. H. Head and S. D. Lee.

G-38 The Endocrine Regulation of Glucogenesis and Glucose Metabolism as Related to Milk Secretion. W. F. Williams, R. F. Davis, H. H. Head and J. D. Connolly.

G-39 Studies on the Mode of Digestion, Absorption and Utilization of Feeds by Ruminants and Their Associated Bacteria. W. E. Stewart, R. N. Doetsch, P. J. Provost, G. J. Hageage and R. F. Davis.

G-40 Influence of High Temperature Heat Treatment on Certain Physical and Chemical Properties of Milk. Mark Keeney and Ira Katz.

G-42 Methods of Processing and Other Factors Affecting the Quality of Ice Cream. W. S. Arbuckle, William Venter, Jr. and E. P. Valaer.

G-46 The Relationship of the Hypophyseal Growth Hormone and of the Pituitary-Adrenal System to the Productive Capacity of Dairy Cattle for Reproduction and Milk Production. W. F. Williams and S. D. Lee.

G-47 The Nutritive Evaluation of Forages. R. W. Hemken, R. F. Davis, N. A. Clark and F. S. Hazlett.

G-48 Flavor Quality of Concentrated Milk Products as a Factor in Milk Utilization and Marketing. Mark Keeney.

G-50 The Physiology of Mammary Gland Growth and Development and the Initiation and Maintenance of Lactation with Particular Reference to Endocrine Relationships. W. F. Williams, R. F. Davis and R. D. Conover.

G-51 A Study of the Effects of Pelleting and Heating of Feeds Upon Body Composition, Growth and Milk Secretion in Ruminants. R. L. King, R. W. Hemken, F. S. Hazlett and J. H. Vandersall.

G-52 A Study of Factors Affecting the Voluntary Intake Availability and Utilization of Nutrients in Forages for Growth and Milk Production. J. H. Vandersall, R. W. Hemken, N. A. Clark and R. F. Davis.

GC-45 A Study of the Causes and Prevention of Bloat in Ruminants. E. C. Leffel, R. N. Doetsch, R. J. Komarek, P. J. Provost and G. J. Hageage.

Department of Entomology

H-29-n Chemical Control of Insect Pests of Sweet Corn. L. P. Ditman and F. P. Harrison.

H-35-b Nursery Insects. The Control of Arthropod Pests of Azalea with Systemic Insecticides. W. T. Johnson and W. E. Bickley.

H-46-e Continued Studies on the Efficiency of Fixed-Boom Low-Volume Sprayers and the Development of New Insecticides. L. P. Ditman, W. E. Bickley and G. J. Burkhardt.

H-48 Control of Codling Moth and Careful Observations on Possibility of Resistant Strains. W. E. Bickley, Castillo Graham and E. R. Krestensen.

H-56 Patuxtent Project on the Effect of Soil Conservation Upon Insect Populations. H. B. Owens, L. P. Ditman and W. E. Bickley.

H-61 The Biology and Distribution of *Macropsis Trimaculata* Fitch. E. R. Krestensen and W. E. Bickley.

H-64 An Evaluation of the Effectiveness of Commercial Insect Control Practices on Canning Crops. L. P. Ditman.

H-67 Factors Influencing Spray Deposits on Some Vegetable Crops. L. P. Ditman and J. T. Whitlaw, Jr.

H-69 Identification and Control of the Various Species of Mites Causing Damage to Apple Orchards. W. E. Bickley, Castillo Graham and E. R. Krestensen.

H-71-a Investigation of Forage Crop Insects. The Clover Root Curculio. W. G. Phillips, W. E. Bickley and L. P. Ditman.

H-71-c Insects Affecting Soybeans. W. E. Bickley, R. H. Ratcliffe and T. L. Bissell.

H-71-d Alfalfa Insects, Their Biology and Control. A. L. Steinhauer and W. E. Bickley.

H-72 Physiology of Insect Reproduction. J. C. Jones and graduate assistants.

H-73-a Bionomics of Maryland Mosquitoes: The Mosquito Fauna in Selected Swamps, Marshes and Impoundments. W. E. Bickley and P. M. Brickey, Jr.

H-73-c Bionomics of Maryland Mosquitoes: Feeding Habits of Maryland Mosquitoes in Relation of Eastern Equine Encephalitis. W. E. Bickley, J. E. Scenlon and graduate assistants.

H-74 Biology and Control of Tobacco Insects. F. P. Harrison.

H-75 The Taxonomy of the *Aspidiota howardi* CK11. Complex (Homoptera Coccoidea). J. A. Davidson and W. E. Bickley.

H-76 Comparative Morphology and Physiology of Insect Blood Cells. J. C. Jones and graduate assistants.

H-77 The Susceptibility of the Red-Banded Leaf Roller *Argyrotaenia velutinana* (Wlkr.) to TDE. E. R. Krestensen.

H-78 Metabolism of Essential Nutrients and Insecticidal Chemicals in Insects. A. L. Steinhauer and graduate assistants.

H-79 Classification of Green Lacewings (Chrysopidae: neuroptera). W. E. Bickley and R. A. Bram.

QH-58-o Evaluation of Possible Off-Flavors Resulting from the Application of Chemical on Soils and Growing Crops. (In cooperation with Horticulture Department). Amihud Kramer, L. P. Ditman and R. C. Wiley.

Department of Home Economics

Y-1 Interrelationships in the Metabolism of Different Levels of Protein and Fat in the Diet of College Women. Pela Braucher, L. M. Dyke, Virginia Dawson, Genevieve Watkins, Vincent Schultz, Russel Miller, N. O. Price, Barbara Creamer and Conchita Gianzon.

Y-2 Measurements of Air Permeability on Selected Garment Fabrics Before and with Wear. Jewel Golden, T. Faye Mitchell and Eleanor Young.

Department of Horticulture

I-74-a Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Potted Plants. J. B. Shanks, C. B. Link and Le Moyne Hogan.

I-74-b Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Cut Flower Crops. C. B. Link and J. B. Shanks.

I-79-j The Relationship of Growth Regulators and Certain Environmental Factors on the Flowering of the Azalea (Rhododendron). C. B. Link, J. B. Shanks and D. J. Ballantyne.

I-79-k Factors Influencing the Induction Formation, and Development of the Influenescence in *Hydrangea macrophylla* (Thunb.). J. B. Shanks, C. B. Link and P. L. Smeal.

L-73 Adaptation of Fruit Varieties and New Seedlings to Maryland. I. C. Haut, F. J. Lawrence and A. H. Thompson.

L-74 Environmental Factors and Cultural Practices in Relation to the Growth and Fruiting Responses of Fruits. A. H. Thompson, L. E. Scott, F. J. Lawrence, B. L. Rogers, I. C. Haut and S. H. Todd.

L-74-b Chemical Thinning of Apples and Peaches. A. H. Thompson and B. L. Rogers.

L-74-c Boron Nutrition of the Apple in Relation to the Development of Bitter Pit and of Red Color and Finish. A. H. Thompson, A. A. Hewitt, W. J. Bramlage, B. L. Rogers and H. G. Gauch.

L-79-a Relation of the Level of Mineral Nutrients in the Plant to Growth and Fruiting of the Strawberry with Particular Reference to Nitrogen. L. E. Scott, Glenn Stadelbacher, W. A. Matthews and I. C. Haut.

L-79-d Mineral Nutrition of the Apple with Reference and Growth, Fruitfulness and the Development of Internal Bark Necrosis. A. H. Thompson, B. L. Rogers, J. A. Barden, D. R. Heinicke and L. E. Scott.

Q-58-f Development of Objective Grades and Standards and Quality Control Methods for Vegetables. Amihud Kramer, B. A. Twigg, R. C. Wiley, F. W. Cooler and John Ewell.

Q-58-n Suitability of New Varieties of Horticultural Crops for Canning and Freezing. W. L. Hollis, B. A. Twigg, Amihud Kramer, F. C. Stark, L. E. Scott and R. C. Wiley.

Q-58-q Bulk Packaging and Shipping of Raw Vegetables. Amihud Kramer, B. A. Twigg and F. W. Cooler.

Q-74 A Study of Regional Adaptation of Certain Vegetable Crops and Varieties in Maryland. W. L. Hollis, F. C. Stark, L. E. Scott, J. G. Kantzes and W. A. Matthews.

Q-77 Crop Management Studies with Vegetable Crops. W. L. Hollis and F. C. Stark.

Q-79-b The Mineral Levels and Interrelationships of Mineral Nutrients in Fruit Plantings in Maryland. L. E. Scott, A. H. Thompson, D. R. Heinicke, J. A. Barden and B. L. Rogers.

Q-79-g Changes in Chemical Composition of the Sweet Potato During Development, Storage and Processing as Related to Quality of the Final Product. L. E. Scott, W. A. Matthews, F. C. Stark and R. A. Baumgardner.

Q-79-h Influence of Nutrient Intensity and Balance on the Growth, Yield and Quality of Cauliflower. C. W. Reynolds and F. C. Stark.

Q-81 Cantaloupe Breeding and Selection with Particular Reference to Quality and Resistance to Defoliation. F. C. Stark and W. A. Matthews.

Q-81-b Sweet Potato Breeding and Selection with Particular Reference to Quality and Resistance to Cracking. F. C. Stark, W. A. Matthews and L. E. Scott.

Q-81-c Sweet Corn Breeding with Particular Reference to the Utilization of Cytoplasmic Male Sterility in the Production of F₁ Hybrid Seed Corn. R. J. Snyder and F. C. Stark.

Q-82 Tomato Breeding and Selection with Particular Reference to Greater Resistance to Cracking and to Late Blight. F. C. Stark and W. A. Matthews.

QRA-1 The Retention of Market Quality of Sweet Potatoes by Improved Methods of Harvesting, Grading and Handling. (In cooperation with Agricultural Economics and Agricultural Engineering Departments). L. E. Scott, W. A. Matthews, F. C. Stark, H. S. Todd, G. J. Burkhardt, P. N. Winn and D. A. Swope.

Department of Poultry Husbandry

M-32-l Study of Factors Influencing or Controlling the On-Set of Molt. Mary Juhn, G. D. Quigley and C. S. Shaffner.

M-32-m Genetic Differences in Alkaline Phosphatase Concentration of Blood Sera as Related to Differences in Egg Production and Egg Quality. F. W. Wilcox, C. S. Shaffner and H. V. Auger.

M-33-e Genetic Differences in Alkaline Phosphatase Concentration of Blood Sera as Epizootiology of Equine Encephalitis in Maryland. R. J. Byrne and F. M.

M-34-e Selective Breeding of Medium-Sized Turkeys for Improvement of Economic Qualities. C. S. Shaffner, G. D. Quigley and C. E. Clark.

M-35-m Development of Improved Rations and Feeding Methods for Laying Chickens. G. F. Combs, N. V. Helbacka, D. F. Middendorf, C. S. Shaffner and G. D. Quigley.

M-48 Microbiological Studies Pertaining to Poultry Nutrition. Mary S. Shorb and Pauline Lund.

M-49 Vitamin B₁₂ and Chick Nutrition. Mary S. Shorb, Unabelle B. Blackwood, W. O. Pollard and G. C. Harris.

M-51 Development of Improved Objective Methods for Detecting Meat Spots in the Hen's Egg as Related to Quality in Egg Marketing. N. V. Helbacka.

M-53 A Study of the Relationships Between High Ambient Temperature and the Shell Thickness of Market Eggs. N. V. Helbacka, S. W. Patch, J. L. Casterline and C. S. Shaffner.

M-54 Studies on Energy Requirements of Poultry and the Energy Content of Poultry Feed Ingredients. G. F. Combs and E. H. Bossard.

M-55 The Perception and Preference of Chickens for Different Colors. G. D. Quigley.

M-100 Quality Retention in Poultry Meats as Influenced by Methods of Processing. N. V. Helbacka, S. W. Patch, J. L. Casterline, Milton Rabinowitz and D. E. Matthews.

M-200 Studies on Improved Broiler Nutrition. G. F. Combs, J. L. Nicholson, N. V. Helbacka, D. L. Pope and R. D. Creek.

M-201 Vitamins and Unidentified Organic Factors in Poultry Nutrition. G. F. Combs, W. C. Supplee and R. D. Creek.

M-202 Protein and Amino Acids in Poultry Nutrition. G. F. Combs, P. F. Twining, D. F. Middendorf and D. L. Pope.

M-203 Trace Mineral in Poultry Nutrition. G. F. Combs, W. C. Supplee, R. D. Creek, N. V. Helbacka, D. L. Blamberg and O. D. Keene.

M-204 Nutrition and Bone Anomalies in Chicks and Turkeys. R. D. Creek and Valeria Vasaitis.

M-300 Factors Affecting the Fertilizing Ability of Chicken Semen. F. H. Wilcox, C. S. Shaffner, G. C. Harris, H. L. Wilson and Unabelle B. Blackwood.

M-301 Effect of Ambient Temperature on Efficiency of Broiler Production. C. S. Shaffner, G. F. Combs, D. L. Pope, J. L. Nicholson and G. D. Quigley.

Department of Sociology

S-3 Studies on the Population of Maryland.

S-3-2 Population Change in Maryland and the Northeast.

S-5 Farmer's Attitudes Toward Farming: A Comparative Study of Farm Enterprises.

Department of Veterinary Science

D-52 Respiratory Diseases of Poultry. H. M. DeVolt, P. J. Vasington and A. P. Holst.

D-57 Epizootiology of Equine Encephalitis in Maryland. R. J. Byrne and F. M. Hetrick.

D-58 Infectious Bovine Mastitis. James Kornder and Rita Sue Showalter.

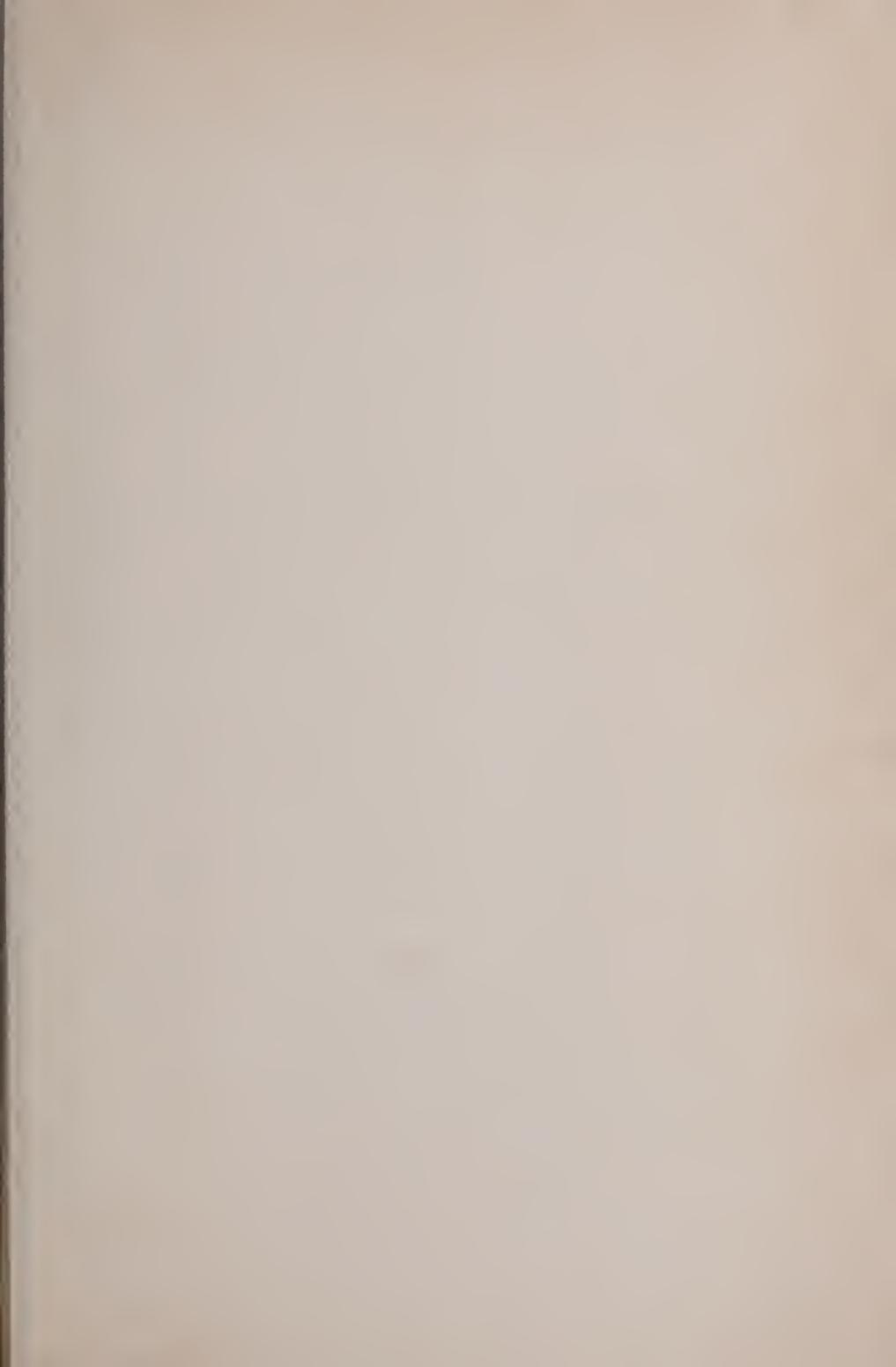
D-59 An Investigation of "Air-Sac Infection" in Poultry. H. M. DeVolt, R. M. Smibert, J. K. Noel and A. P. Holst.

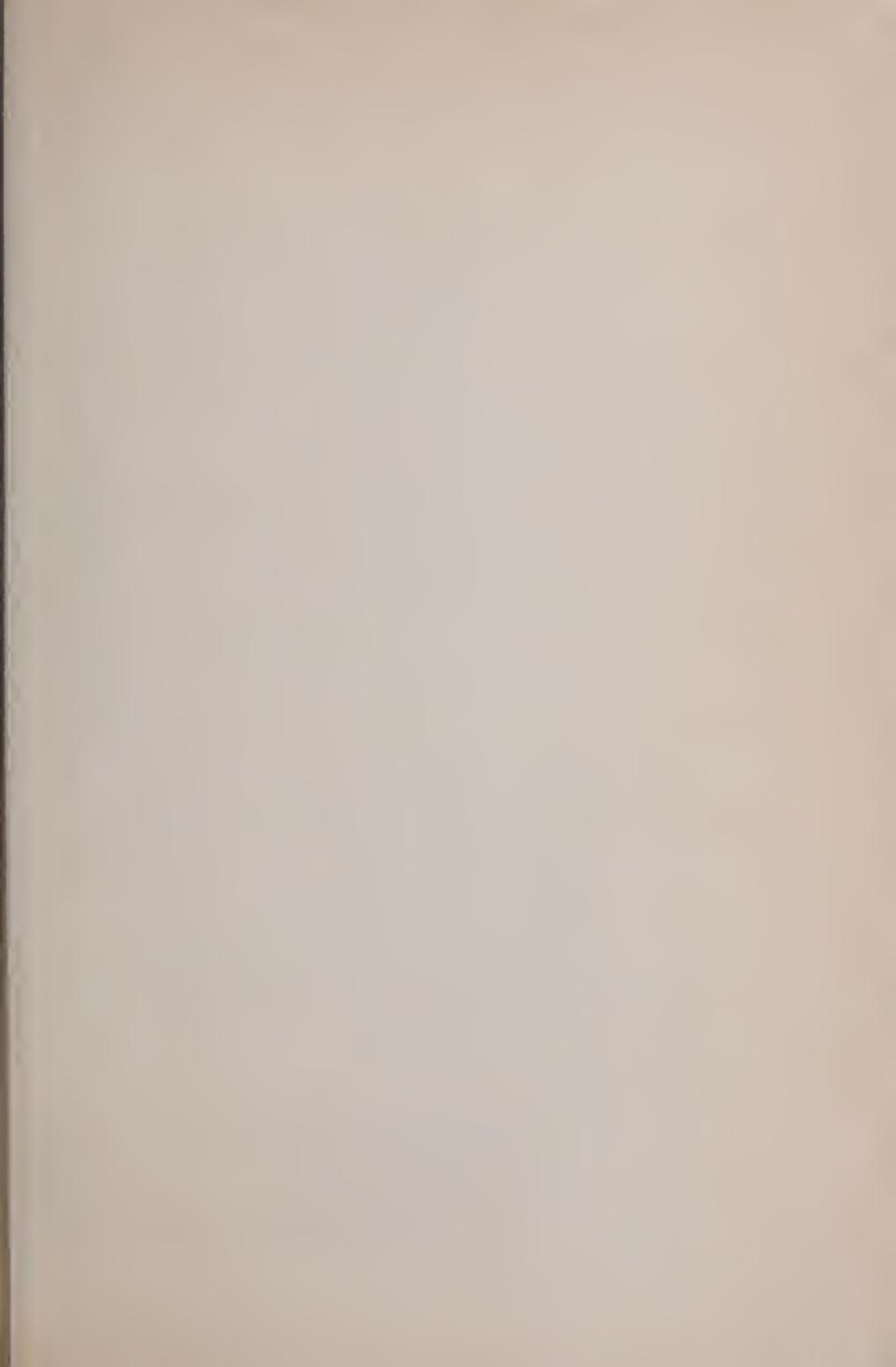
D-60 Investigations on Brucellosis of Cattle. Cornelia Cotton, Claire B. Walford, Gertrude M. Jones and Stephen Seater.

D-61 A Study of Ruminant Metabolism with Emphasis Upon Its Relation to Ketosis. R. B. Johnson.

D-62 Pathology of Breeding Failures in Cattle. G. J. Plumer, William Duvall, L. J. Poelma, R. J. Byrne, F. S. Yancey and W. R. Anderson.

D-63 Study of Bovine Respiratory Diseases. R. J. Byrne, S. C. Chang, L. J. Poelma, F. M. Hetrick and F. R. Abinanti.







In addition to state and federal funds, the research program of the University of Maryland Agricultural Experiment Station has received support during the year from many public, private and industrial organizations and individuals. It is regretted that space does not permit recognition of all sources of help, but the cooperation of all is herewith gratefully acknowledged.

Visitors will be welcome at all times and will be given every opportunity to inspect the work of the Agricultural Experiment Station in all its departments.

The bulletins and reports of the Station will be mailed free of charge to all residents of the State who request them. The more recent publications are listed on pages 71-76.

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